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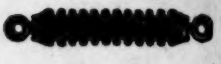
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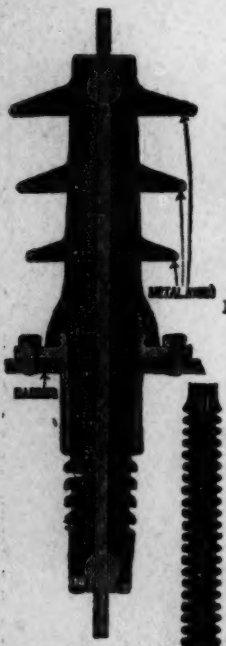
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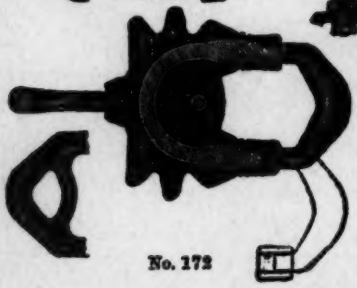
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DESTRUCTION OF THE FLANDERS TRIANGLE

By Lieutenant Z. W. Wicks, U. S. Navy

The first and only real offensive against the German submarine menace in the North Sea and adjacent waters was the attack, successfully carried out, against the submarine base in Flanders. The attack took place on the night of April 22 and 23, 1918, but owing to the miscarriage of a portion of the plan a second attempt at Ostend had to be made. This was accomplished on May 10, 1918.

Zeebrugge Harbor is an open one protected by a quadrantal mole which is connected at one end to the mainland by an iron viaduct. The entrance is well protected on the land side by shallow water. During the German occupation the channel was equipped with a strong net and barge barrier.

This harbor is connected by a ship canal with the inland docks at Bruges, which are further connected to Ostend Harbor by a system of smaller canals. The whole forms a triangle with Bruges at the apex and a sea entrance at each end of the base. The two legs are 8 and 11 miles long respectively and the base 12 miles. At the time this operation was conducted the base of this triangle was heavily fortified and the defences extended along the coast, eastwardly to the Dutch frontier and westwardly to the right flank of the German Army operating before Nieuport. The strength of this stretch of coast, 27½ miles in length, could be reckoned in the number of guns installed, more than

225, or an average of at least 8 to the mile, of which 136 were of not less than 6-inch caliber and some as large as 15-inch, the last ranging up to 42,000 yards.

The Straits of Dover and the English Channel formed a sector of the main line of communication of the British Army and had been greatly harassed by the attacks delivered by the submarines operating from this strongly held base. The proximity of the objectives to the base added greatly to the efficient performance of the smaller types of submarines. After getting in an attack they could make the coast of Flanders before being detected and return to their base under the protection of their shore batteries.

Mission.—The objective of this offensive can be classed as primary and secondary. The primary objective was to block the Bruges ship-canal at its entrance in the harbor of Zeebrugge, and to block the entrance to Ostend Harbor from the sea; a successful accomplishment of which would have meant, practically, the destruction of the triangle, leaving only its fortified base as of military importance. The secondary objective was to accomplish as much damage as possible to the fortified ports of Zeebrugge and Ostend, or in other words to the base of the triangle, while at the same time causing a distraction from the main attack.

Plan of Attack.—With the objectives clearly defined it was necessary to draw up a comprehensive plan of attack before the preparation of material and the training of the personnel could be undertaken, on account of the singularity of the operation.

The following summary of suppositions and decisions is offered by the writer to show what the undertaking faced and is considered sufficient for a clear understanding without encumbering the narrative with a mass of technical detail.

Suppositions.—(a) A strong German raiding or patrol force might be encountered.

(b) It was believed that the shallow waters in the vicinity of Zeebrugge and Ostend were heavily mined.

(c) A strong counter-attack by the German destroyer flotilla lying behind the Zeebrugge Mole might be expected.

(d) Good protection was afforded the entrance of the Zeebrugge-Bruges Canal by the Mole, heavy shore batteries and shoal water.

(e) During an attack on the Mole the defenders could receive reinforcements from land over the iron viaduct.

ZEEBRUGGE HARBOR WITH GERMAN DEFENCES AND BRITISH BLOCKSHIPS.

(f) The blocking of the canal entrance at Zeebrugge could be accomplished in two ways: (1) Ram the lock gates and sink the ramming ship in place; (2) sink two ships across the entrance at its narrowest part and rely on silting to complete the operation.

(g) The blocking of the Ostend entrance could be fulfilled by sinking one or more ships across the channel between the piers.

(h) A dark night with absence of fog and a certain state of the tide are necessary for maneuvering the force. Some kind of protection must be provided to conceal the approach.

Note.—It seems to be evident from the published reports of this operation that the probable presence of a harbor net at Zeebrugge was not taken into consideration.

Decisions.—(a) A strong covering force of light cruisers and destroyers is to be maintained to the eastward and northward of Zeebrugge. This force to be drawn from Harwich.

(b) The presence of mines must be expected and the operation must proceed without taking them into account. Shallow draft vessels in sufficient number must accompany the deeper draft vessels in order to take off all personnel in case of the loss of any of the latter.

(c) The attacking force must be accompanied and covered by a force of destroyers sufficient to repel an attack by the enemy's full force of destroyers based on Zeebrugge.

(d) The strength of the protection of the entrance to the canal at Zeebrugge necessitates the employment of feints to attract the defender's attention from the main attack. This is to be accomplished by two means, viz: (1) the bombardment of adjacent batteries by monitors (covered by destroyers) and airplanes on prearranged targets; (2) an attack in force on the Mole, the landing to be effected on the seaward side and as nearly as possible abreast of the battery located on the Mole Head, the silencing of which is considered necessary for the safe passage of the block ships. Then the attack is to be continued to the westward along the Mole followed by a demolition party for the purpose of accomplishing as much damage as possible during the time required to carry out the main operation.

Due to the exposed entrance of the harbor at Ostend the only feint to be undertaken will be the heavy bombardment of the shore batteries by monitors (protected by destroyers), airplanes and siege guns on preassigned targets.

(e) In order to prevent reinforcements reaching the defenders of the Mole the iron viaduct must be destroyed. This is to be accomplished by fitting two old submarines with large quantities of explosives, ramming the viaduct from the seaward side and detonating the charges.

(f) Three block ships are to be used at Zeebrugge. The block ships will proceed into the canal, timed to arrive about 25 minutes after the opening of the attack on the Mole. The leading ship, if her consorts are seen to be following, is to ram the lock gates and be sunk, the other vessels are to be run ashore near the entrance at the southern end of the piers, the narrowest part of the channel, and to be sunk. If the leading vessel should fail to reach the lock gates and should sink in the channel short of them she would make no obstruction. If only two of the block ships reach the canal they are to be sunk across the channel near the southern end of the piers.

(g) Two block ships are to be used at Ostend. Each ship in turn will ram one of the piers and then swing the ship across the channel in which position the sinking charges will be exploded.

(h) A smoke screen must be laid close to the enemy's position, to be laid down after the commencement of the bombardment, but before the arrival of the force for the attack on the Mole and of the block ships. Flotillas of motor launches and coastal motor boats are to be used for this duty and they will have rescue work as an additional duty.

Composition of Forces.—In order that all parts of the English Naval Service might share in this expedition officers and men were drawn from all parts of the home forces. The ships, destroyers and small craft were drawn from the Dover patrol, Harwich force and Dunkirk, augmented by eight destroyers and four motor launches from the French Navy. The block ships and submarines were obtained from Portsmouth and the Nore.

The total force was composed as follows:

Monitors	8	Parent ships, etc.	3
Light cruisers	8	Block ships	5
Flotilla leaders	7	Submarines	2
Destroyers	45	Mine-sweepers	1
Motor launches	62	Auxiliary craft	2
Picket boat	1	Airplane squadrons	2
Coastal motor boats	24		

In addition to the crews of such of the above ships as were in commission there was a force of 82 officers and 1698 men—Royal Navy 50 officers and 980 men, Royal Marines 32 officers and 718 men—for the manning of the other ships and the formation of the storming and demolition parties.

Preparation.—A force thus composed and its weapons obviously needed collective training and special preparation to adapt them to the purpose.

The *Vindictive* was chosen to make the attack on the Mole. She was fitted out at the Chatham Dockyard with special fenders, mole anchors for making fast to the Mole, and brows to expedite the landing of the attacking force. Her light gun armament was increased especially by the placing of machine guns and flame throwers.

Two special craft were necessary to accompany the *Vindictive*. The Liverpool ferry-steamers *Iris*—renamed *Iris II*—and *Daffodil* were selected after a long and careful search on account of their power, large carrying capacity and shallow draft. They were chosen with the view of pushing the *Vindictive* alongside of the Mole; bringing away all of the crew and landing parties of the *Vindictive* if she should be sunk; and their ability to maneuver in shallow water and to clear mine fields and torpedoes. They were refitted for this work much in the manner as the *Vindictive* at the Portsmouth dockyard.

The following ships were selected for block ships: At Zeebrugge, the *Thetis, Intrepid* and *Iphigenia;* at Ostend, the *Sirius* and *Brilliant*. Their holds were filled with cement and two sets of explosive charges were installed in each vessel at the Chatham dockyard.

The smoke producing apparatus in vogue was only intended for day use and was entirely unsuitable for this expedition as its combustion was accompanied by a bright flame. A new and satisfactory system was evolved by Wing Commander F. A. Brock, later killed during the attack. This equipment was manufactured and installed on the motor launches, coastal motor boats and destroyers at Dover.

As soon as the preparation of the material was sufficiently advanced the training of the personnel was commenced. With this end in view the block ships and the storming forces were assembled at Chatham towards the end of February. The *Hin-*

dustan was used as receiving ship and training depot. On the 4th of April this force was moved to the West Severn anchorage.

The storming forces were composed as follows: Naval companies A, B and D; and the 4th Battalion of Royal Marines, companies A, B, C and machine gun. The demolition force was known as the Naval Company C and was divided into three sections.

For several weeks the 61st Wing was engaged in frequent aerial reconnaissances and took a large number of photographs in different conditions of the tide, from which plans and models were constructed. The storming and demolition parties were trained on a replica of the Zeebrugge Mole until each company became thoroughly acquainted with its share of the undertaking. This training was carried out in accordance with a plan to place the *Vindictive* abreast of the battery on the seaward end of the Mole.

To assure the efficient co-operation of all of the various forces it was found necessary to place navigational marks at certain turning points and to mark the positions to be taken by the monitors in order to assure the bombardment of all preassigned targets. This was well accomplished except at Ostend, where too much confidence was placed on the Storm Bank Buoy.

In order that the attack might have a reasonable prospect of success the following conditions were essential, viz: (a) a certain state of the tide in conjunction with darkness; (b) relatively calm weather; (c) more or less favorable direction of the wind; (d) absence of fog. The first of these fixed the dates between which it was practicable to make the attempt. The others it was not possible to reckon with in advance, owing to the uncertainty of the weather at that time of the year, owing to the fact that the weather conditions on the Flanders coast might be different than they were off the Goodwins and owing to a possible change in the seven hours necessary to make the passage from the point of concentration to the point of attack.

On two occasions previous to April 22d, the concentration took place, but on account of unfavorable weather conditions setting in, had to be dispersed. Although this caused great disappointment to the personnel it had considerable practical value as dress rehearsals of the preliminary stages of the undertaking.

The last of the preparations was the long-range bombardment of the Flanders coast, carried out on several nights prior to

April 22 in order to give the Germans no reason to anticipate further action on that occasion.

Disposition of the Forces

(a) In the Swain:

For attack on Zeebrugge Mole: *Vindictive, Iris II, Daffodil.*

To block Bruges Canal: *Thetis, Intrepid, Iphigenia.*

To block entrance at Ostend: *Sirius, Brilliant.*

(b) At Dover:

Destroyer *Warwick* (flagship).

Unit L: *Phoebe* and *North Star.*

Unit M: *Trident* and *Mansfield.*

Unit N: *Whirlwind* and *Myngs.*

Unit R: *Velox, Morris, Moorsom, Melpomene.*

Unit X: *Tempest* and *Tetrach.*

To damage Zeebrugge viaduct: Submarines *C-1* and *C-3.*

A special picket boat to rescue crews of submarines.

Mine-sweeper *Lingfield* to take off surplus steaming watch from the block ships.

Eighteen coastal motor boats, thirty-three motor launches. — To lay smoke screen and do rescue work.

To bombard vicinity of Zeebrugge: Monitors *Erebus* and *Terror.*

To cover monitors: *Termagant, Truculent* and *Manly.*

Outer patrol off Zeebrugge: *Attentive, Scott, Ulleswater, Teazer* and *Stork.*

(c) At Dunkirk:

Monitors for bombarding Ostend: *Marshall, Soult, Lord Clive, Prince Eugene, General Crawford, M-24* and *M-26.*

To cover monitors: British—*Mentos, Lightfoot* and *Zubrian;* French—*Lestin, Capitaine Mehl, Francis Garnier, Roux* and *Boucher.*

Six British coastal motor boats, eighteen British motor launches, four French motor launches. — To lay inshore smoke screen and do rescue work.

(d) At Harwich:

Covering force of light cruisers and destroyers.

The Attack.—This undertaking having been made by two separate forces acting at the same time, the operations against Zeebrugge and Ostend will be taken up separately and the former will be divided into the attack on the Mole, blocking operations and the Inshore Covering force.

The Harwich force of light cruisers and destroyers under command of Rear Admiral Sir Reginald Tyrwhitt, K. C. B., D. S. O., took up its covering position to the northward and eastward of Zeebrugge to prevent any interference from seaward by the Germans.

The main force under command of Vice Admiral Sir Roger Keyes, K. C. B., C. M. G., M. V. O., D. S. O., in the *Warwick*, assembled off the Goodwins in the afternoon of April 22, 1918. There it formed in three columns. The center column was headed by the *Vindictive* towing the *Iris II* and *Daffodil*, followed by the five block ships and the mine-sweeper *Lingfield*, the latter escorting five motor launches to be used in taking off the surplus steaming watches from the block ships. The starboard column was led by the *Warwick* followed by the *Phoebe* and *North Star*, the *Trident* towing the *C-3*, the *Mansfield* towing the *C-1* and the *Tempest*. The port column was headed by the *Whirlwind* followed, in order named, by the *Myngs*, *Moorsom* and *Tetrach*. Every craft had in tow one or more coastal motor boats and the motor launches were distributed between columns.

In this formation and escorted by the 61st Wing, the force got under way at 4.53 p. m. and stood towards the point at which the outer patrol off Zeebrugge was stationed. When within about 1½ miles of this position the whole force stopped for about 15 minutes. The surplus steaming crews were taken off by the motor launches and put aboard the mine-sweeper *Lingfield*. All the tow lines except on the submarines were slipped. The *Sirius* and *Brilliant* escorted by the *Tempest* and *Tetrach* drew off towards Ostend. The motor launches and coastal motor boats drew ahead to get into position for laying the smoke-screen. These arrangements having been completed the *Vindictive* followed by the *Iris II*, *Daffodil* and the block ships and escorted by destroyers on either bow, proceeded towards Zeebrugge.

The monitors and their destroyer covering forces, having proceeded independently to their stations, commenced the bombardment of the defences of Zeebrugge and those of Ostend simultaneously at 11.20 p. m. This bombardment had been slightly delayed by the strong set of the tide and the presence of thick weather along the Flanders coast. The drizzle and low clouds prevented the operation of the 65th Wing which was to have assisted in the attack on Ostend.

ZEEBRUGGE.—At 11.30 p. m., the *Vindictive* had the Blankenberghe light buoy abeam and the Germans had apparently seen or heard the approaching forces, as many star shells were fired, lighting up the vicinity and revealing no enemy patrol vessels to the attacking force. At this time the wind which had been from the northeast and favorable to the smoke screen died out and soon sprung up from a southerly direction.

The flotilla of 24 motor launches and 8 coastal motor boats which had been detailed for laying the smoke screen commenced its operations when the C. M. B.'s ran in close to the Mole and started dropping their smoke boxes at 11.40 p. m. This operation continued steadily and the flotilla was subjected to a heavy fire, but suffered little damage on account of their small size and high speed. The effectiveness of the screen was lessened considerably by the adverse direction of the wind and by the sinking of many of the floats by shell fire from the shore batteries, especially those which showed a flame and those which were placed near the end of the Mole.

The Mole Attack.—The attack on the Mole was primarily to distract the enemy's attention from the ships engaged in blocking the Bruges Canal. Its first objective was the capture or silencing of the battery located on the seaward end of the Mole, which was a serious menace to the passage of the block ships. Its second objective was the execution of as much damage as possible during the time necessary for the block ships to accomplish their mission.

When the *Vindictive* arrived at the position where it was necessary for her to alter course for the Mole, the three destroyers, *Warwick, Phoebe* and *North Star,* bore off to starboard and cruised in the vicinity of the Mole and covered the landing. These destroyers were also employed in assisting the small craft to maintain the smoke screen.

At 11.56 p. m., the *Vindictive* having just passed through the smoke screen, the Mole extension was sighted about 300 yards on her port bow. The Mole was closed at full speed and on such a course as, with the cross tide, made the closing angle about 45 degrees. As soon as the ship emerged from the smoke screen she was subjected to a heavy fire and in turn opened fire almost simultaneously with her port battery. The storming parties suffered severely under this fire; the commander of the Naval Battalion and the commander and second in command of the Marine Battalion were all killed.

At one minute after midnight on April 23—the programme time having been midnight—the *Vindictive* was put alongside of the Mole, taking up on the special fenders on her port bow, and the starboard anchor was let go. As there was some doubt of the latter having dropped clear, the port anchor was dropped under foot and hove in to short stay. A 3-knot tide running past the Mole and the scend created by a slight swell caused the ship to roll considerably.

At 12.04 a. m. the *Daffodil*, closely followed by the *Iris II*, arrived. The former immediately took up position and pushed the *Vindictive* bodily against the Mole. Two brows were gotten over from the forecastle of the *Vindictive* and in spite of the heavy see-sawing of the ends on the Mole, due to the motion of the ship, the landing parties commenced to land under heavy fire. Their first duty was to place the special mole-anchors. The forward one was broken up between the ship and the Mole as it was being carried out. The rest were soon in place and two brows aft were run out.

It had been intended for the *Daffodil* to go alongside the *Vindictive* to land her detachment of the storming force, but it was found necessary to keep her holding the *Vindictive* against the Mole throughout the action. The portion of the landing parties aboard her disembarked over her bow to the *Vindictive*, thence ashore.

The *Iris II* went alongside the Mole ahead of the *Vindictive*. The scend alongside caused her to bump heavily and the use of her scaling ladders was difficult and dangerous. Her two mole-anchors were secured under the most trying conditions, the two officers who performed the work being killed. However, it was impossible to get them to hold and in the end the *Iris II* dropped

down alongside of the *Vindictive*. The disembarkation of her detachment of the storming party had only commenced when the retiring signal was given.

The first to land on the parapet, the raised portion of the Mole on the seaward side with a drop of 15 feet to the Mole proper, were A and B companies of the Naval Battalion, D company being embarked on the *Iris II*. To them had been assigned the duty of silencing the battery on the Mole Head. Due to the impossibility of recognizing objects in the semi-darkness the *Vindictive* had overrun her intended position about 400 yards. Hence

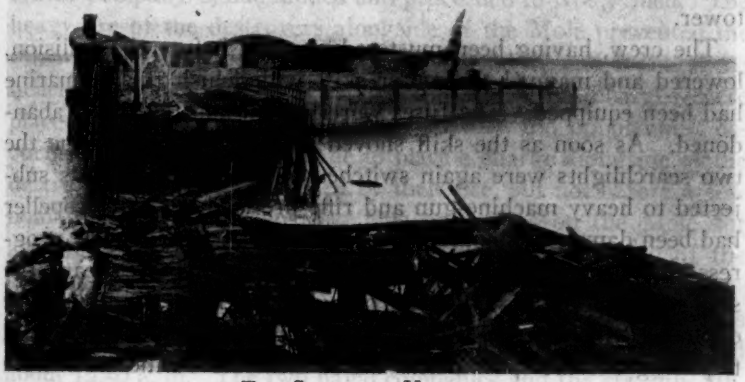
ZEEBRUGGE HARBOR.

these two companies found a fortified zone between them and their objective.

This force was soon followed by Companies B and C and part of the Machine Gun Company, platoons 5 to 12 inclusive, of the Royal Marines. Company A and the remainder of the Machine Gun Company were on board the *Iris II*. To these had been assigned the mission of taking the fortified zone, referred to in the preceding paragraph, and then to proceed to the westward along the Mole and hold a position which would protect the demolition parties.

The two naval companies, considerably reduced in effectives by their losses on the *Vindictive*, but accompanied by a detachment of flame throwers, advanced along the parapet to the eastward. A look-out or control station was encountered and a

bomb thrown into it. However, it was unoccupied. In its vicinity there was an iron ladder leading to the Mole proper. Three of the party descended for the purpose of preventing the passage of the defenders. The rest of the party proceeded to a point about 40 yards eastward of the look-out station and held a position protected from fire from the direction of the Mole Head, but exposed to the machine gun fire of the destroyers lying alongside the Mole. The force was too small to carry the fortified zone by assault and reinforcements were sent for.



THE SHATTERED VIADUCT.

Number 5 platoon of the Marines was the first of the battalion to land. It advanced along the parapet to the westward, silenced a party of snipers in No. 2 Shed and took up position about 200 yards from the *Vindictive*. The 9th and 10th platoons soon followed and descended to the Mole by ropes secured to the iron railing. They took up a strong position at the landward end of No. 3 Shed. Number 7 platoon following close behind fixed heavy scaling ladders in position from the parapet to the Mole and then took up a supporting position on the 9th and 10th platoons.

The rest of the Marines and the demolition company, in the meantime, had landed and were forming on the parapet when at 12.20 a. m. the Mole was successfully cut off from the shore. After slipping the tow of the destroyer the submarine *C-3* pro-

ceeded under her own power and shortly after midnight sighted the viaduct ahead, distant about one and a half miles. Soon after this the light of a star shell exposed her and she was subjected to shell fire for a short period. When about a half mile off, an opportune flare, on the far side, silhouetted the Mole and viaduct which showed two points on the port bow. At this point two searchlights were turned on her but quickly taken off. Her course was changed, when 100 yards off, to ensure striking exactly at right angles. At 12.15 a. m. the *C-3* struck exactly between two rows of piers at a speed of nine and a half knots. Riding up on to the horizontal girders of the viaduct and raising the hull bodily about two feet, she penetrated up to the conning tower.

The crew, having been mustered on deck before the collision, lowered and manned the motor skiff with which the submarine had been equipped. The fuses were lighted and the vessel abandoned. As soon as the skiff shoved off from the submarine the two searchlights were again switched on and the craft was subjected to heavy machine-gun and rifle fire. The skiff's propeller had been damaged, so oars were broken out. As only slow progress could be made against the tidal current by this means the skiff was only a short distance off when, at 12.20 a. m., the *C-3* exploded. The two searchlights were immediately put out and the firing became spasmodic. Three members of the crew were wounded and the skiff badly holed before they were picked up by the picket boat detached for that purpose. It is well to note at this point that the *C-3* had been equipped with a gyrosteering gear in order to permit the abandoning of the craft at a safe distance. The use of this was ignored in order to make as certain as possible the successful carrying out of the mission.

During this time the port 6-inch battery, the forward 7".5 howitzer and machine guns in the top of the *Vindictive* were covering the operations in an excellent manner. At the forward howitzer two gun's crews were practically wiped out. The ship was being hit every few seconds, especially in the upper works. Two direct hits were made on the fore-top, killing all but one marine sergeant, who continued to operate a machine-gun until a third shot demolished the top. The operations were well lighted by rockets from the *Vindictive* and German star shells.

While awaiting the coming of reinforcements Naval Companies A and B made a spirited attack along the parapet, but were stopped with heavy losses. The 11th and 12th platoons of Marines were dispatched to their assistance and advanced as far as the look-out station. They were prevented from joining the naval companies by the heavy fire which swept the parapet between the two forces. Meanwhile the 5th platoon was recalled from its advanced position. This platoon with the 7th and 8th were formed for an assault on the fortified zone and the attack was launched.

While these operations were proceeding, the demolition party, Naval Company C, had landed and proceeded to No. 3 Shed. The heavy fire of the destroyers alongside of the Mole prevented the 9th and 10th platoons from advancing beyond the end of this shed; hence its demolition was impossible. However, charges were placed and everything made ready in case the opportunity occurred. An attempt was made to place a charge alongside of the destroyers but it was repulsed by their fire, but not before a few bombs were thrown aboard. This party was on the Mole for about three-quarters of an hour and only the proximity of the storming parties prevented considerable destruction.

Before the newly launched attack on the fortified zone was fully developed the general recall was sounded, which occurred about 12.50 a. m. The two naval companies and the 5th, 7th, 8th, 11th and 12th Marine platoons, bringing their wounded with them, retired in good order along the parapet and commenced the re-embarkation. Although this force did not complete its mission, its fire against the Mole Head battery was no doubt instrumental in preventing that battery from firing on the block ships.

The retiring of the 9th and 10th platoons and the demolition party was not so easily accomplished. Several of the scaling ladders from the Mole to the parapet had been destroyed by shell fire. This section of the Mole was being raked by the Germans and the men were sent across in small batches from the comparative shelter of No. 3 Shed. Such rushes took place as far as possible in the intervals between the bursts of fire.

By 1.10 a. m. the withdrawal was completed and five minutes later the *Vindictive* and her two consorts were clear of the Mole, the bow of the *Vindictive* having been towed out by the *Daffodil*. While drawing away, the *Iris II* was especially sub-

jected to heavy fire from the Mole and shore batteries. She was struck by 13 small shells and two large ones, one of the latter carrying away the port side of the bridge and starting a fire in the vicinity of the ammunition. *M. L.-558* came to her assistance and threw up a heavy smoke-screen between her and the shore which enabled her to get clear. The *Iris II,* in a very badly damaged condition, made Dover at 2.45 p. m., the *Vindictive* having arrived at 8. a. m.

It had been planned to use two submarines to destroy the viaduct. The *C-1,* owing to the delay caused by the parting of the tow-line, did not arrive in the vicinity of the viaduct until after the retirement had commenced. Her commanding officer, realizing that the engagement was over and considering that the boat might be required at another time, withdrew.

Blocking Operations.—The mission of the block ships has been given in the brief of Decisions. *M. L.-110* was detailed to precede the block ships into the harbor and to light the entrances of the harbor and of the canal with calcium flares. While approaching the entrance she was struck by three shells which killed and wounded half of the crew and wrecked the engines. The craft was abandoned and soon sank.

The three block ships proceeded in column in the following order: *Thetis, Intrepid, Iphigenia.* Shortly after midnight the *Thetis* sighted the Mole ahead and signalled this fact to the ships astern. The Mole Head and extension were lighted up by rockets fired from the *Vindictive* and *M. L.-558* hailed and gave the bearing of the lighthouse.

The *Thetis,* having rounded the lighthouse at 12.15 a. m.—on time in accordance with the arrangements—sighted the barge-boom across the channel. She proceeded at full speed towards the barge furthest from the Mole, and at the same time opened fire at the lighthouse, later shifted to the inshore barge, which was sunk by shell fire. The ship was subjected to a heavy fire from the light guns on the Mole extension, but apparently received no fire from the heavier battery on the Mole Head.

As the *Thetis* approached what appeared to be an opening between the barges and the net obstruction extending to the southeastward of them, she was given hard right rudder, but ran into the net between the two end buoys. She continued to forge ahead and carried the nets with her, thus clearing a pas-

sage for the ships behind her. The piers of the canal entrance were in sight when both of her engines brought up due to fouling of the propellers by the net. The tide quickly carried her shoreward and she grounded about 300 yards from the eastern pier. Whereupon she signalled the other ships to pass to starboard of her and turned on her starboard running light which aided in showing up the canal entrance.

At this time she had a list to starboard and was settling down, having been holed at the water-line on the starboard side several times. She continued to be hit from the Mole, from craft alongside of it and from the shore batteries to which she replied with the forecastle 6-inch gun until her own smoke made it impossible to see. By the time the other two ships had passed, her starboard engine was started. The vessel moved ahead but her bow swung off to starboard into the dredged channel. As the ship was in a sinking condition the order was given to abandon ship and the sinking charges were fired by the after set of keys. They detonated well and the ship quickly sank. The crew abandoned ship in the one remaining cutter and were soon picked up by *M. L.-526*, which had followed in for that purpose and was lying close by. From the aerial photographs which were taken after the action, it appears that the *Thetis* made her way entirely across the dredged channel under her starboard engine, before she finally sank.

The *Intrepid* had been unable to get rid of her spare fire-room watch, on account of the *M. L.* not getting alongside, and hence proceeded to her mission with a crew of 87 officers and men instead of 54. On approaching the Mole she was subjected to a heavy shrapnel fire. She rounded the lighthouse, passed the *Thetis* on her port hand and steered for the canal entrance. Few guns fired at her as most of the firing was directed against the Mole and the *Thetis*. On reaching her assigned position in the entrance she was turned to port under hard left rudder, starboard engine full speed ahead and the port one full speed astern.

The order was given to abandon ship, but before all of the crew had disembarked the ship picked up sternway and her bow drew away from the eastern bank where it had grounded. The sinking charges were immediately exploded and the ship sank, only partially blocking the channel. Ship was abandoned in two cutters and a Carley life-raft. One of the cutters was picked

up by *M. L.-526,* the other by the destroyer *Whirlwind* and the two officers and four men on the life-raft by *M. L.-282,* which had been brought right into the channel, under heavy fire.

The *Iphigenia* also had not succeeded in discharging all of her extra steaming watch and was therefore encumbered with extra men. She was subjected to shrapnel fire the same as the *Intrepid,* while approaching the Mole. Just as she rounded the lighthouse a star shell showed up the *Intrepid* headed for the canal and the *Thetis* aground. While passing towards the canal entrance she was holed twice; one shell cut the siren steam-pipe and thus the fore part of the ship was enveloped in steam.

The entrance became obscured by smoke so that the *Iphigenia* ran in between a dredge and barge. She cut them apart and pushed the barge ahead of her into the canal. At this point it was noted that the *Intrepid* was aground on the western bank with a gap between her and the eastern shore. Having cleared the barge, the *Iphigenia* went ahead full speed to close this gap and collided with the port bow of the *Intrepid.* But her beam was not sufficient to complete the blocking of the entrance at that point. She was backed clear of the *Intrepid* and her engines put full ahead. As soon as she gathered headway she was turned to port under hard left rudder assisted by her engines. She quickly grounded at the bow on the eastern bank and laid completely across the channel with her stern on the western shoal. At 12.45 a. m. the sinking charges were detonated and the crew abandoned ship in one cutter, overcrowded and damaged, which was picked up by the *M. L.-282.* All but three of the crew were taken aboard the motor launch, the cutter was secured to the bow and the launch backed out of the channel at full speed.

Inshore Covering Force.—The *Trident* and *Mansfield,* after parting company with the submarines, covered the western smoke-screen flotilla; the *Whirlwind, Myngs, Velox, Morris, Moorsom* and *Melpomene* covered the eastern one. The *Warwick, Phoebe* and *North Star* cruised in the vicinity of the Mole to protect the Mole assaulting force from torpedo attack. The *North Star* lost her bearings in the smoke and emerged from the smoke-screen to the southeastward of the lighthouse. She fired all of her torpedoes at some vessels moored alongside of the Mole and withdrew. But coming under a heavy fire at point blank range she was quickly disabled and soon in a sinking condition.

The *Phoebe* came to her rescue, circled her repeatedly, threw a smoke-screen around her and took her in tow twice; the first time the tow line was shot away and the second time it parted. Then the *Phoebe* went alongside to tow from that position, but as the *North Star* was rapidly settling she had to be abandoned, the former taking off all of her crew.

The flotilla of coastal motor boats after executing its smoke-screen carried out independent attacks on the German vessels within the harbor. *C. M. B.-5* attacked a destroyer which was under way and damaged her with a torpedo which struck below the forward searchlight, putting it out. *C. M. B.-7* fired a torpedo at a destroyer moored to the Mole and struck her under the bridge. *C. M. B.-32A* struck the steamship Brussels with her torpedo. An explosion followed but the result was hidden by smoke.

OSTEND.—The blocking of the Ostend harbor entrance required two attempts, one on April 22-23, which failed, and the other in the early morning of May 10.

First Attack.—The attack on April 22-23 took place simultaneously with the one at Zeebrugge. The monitors and siege guns opened fire at 11.20 p. m. This bombardment was undoubtedly useful as a blind and kept down the fire on the smoke-screen flotilla and the block ships. The smoke-screen was commenced at 11.40 p. m. with good results. However at 11.50 p. m., when the block ships were standing towards Stroom Bank Buoy, the wind suddenly shifted from the northwestward to the southwestward which greatly interfered with the subsequent actions. The smoke-flotilla tried to combat with this change, but was unsuccessful and was subjected to a heavy but ill-directed fire.

At midnight the block ships passed to the northward of Stroom Bank Buoy, where they first came under fire and laid a dead reckoning course for the pier ends, as no marks were visible due to the smoke. This condition also made it necessary for the *Sirius* to keep close station on the *Brilliant* which was leading. When the Ostend piers should have been seen by the *Brilliant* breakers were sighted on her starboard bow and, although the rudder was put hard left, she grounded. The *Sirius*, observing this, put her rudder hard over and reversed full speed. However, as she was badly damaged by shell fire and sinking she did not answer the helm and collided with the port quarter

of the *Brilliant*. Both ships, being practically aground and in a sinking condition, were blown up and sank about 2400 yards east of the canal entrance. Most of both crews were picked up by *M. L.-532*, *M. L.-276* and *M. L.-283*, each of the last two having gone alongside of one of the ships. *C. M. B.-10* later went alongside of the *Sirius* and determined that none of her crew were left aboard. One small party from the *Sirius* left in a pulling boat and were picked up by the light cruiser *Attentive*, 13 miles from Ostend.

At 1.00 a. m. the retirement signal was given for the whole force. The covering force of destroyers cruised in the vicinity until daylight, searching for any of the small craft which might have been in need of assistance.

The failure of this attack was due to the unknown shifting of Stroom Bank Buoy about 2400 yards to the eastward and the fact that the adverse wind had so placed the smoke-screen that all marks, which might have retrieved the error of the buoy's position, were obliterated.

Second Attack.—The *Vindictive* was available for use as a block ship for a new attempt to block Ostend. Work of refitting her was commenced immediately at Dover in order to make the try on the same tide. This work was carried out night and day to completion by the desired date. Two hundred tons of cement were placed in her after magazines and upper bunkers, which was all that her draft would permit. However, the weather conditions were unfavorable and the action had to be postponed for about two weeks when the necessary conjunction of tide and darkness would again occur.

This delay allowed the securing of the old cruiser *Sappho* for a second block ship. She was fitted out in the same manner as the others at Chatham dockyard. The Germans on the other hand had considerably increased their force of destroyers at Zeebrugge.

The plan of attack was in general the same as the previous one except that the bombardment by the monitors, siege guns and airplanes was to be delayed until the approach of the attacking force was discovered. In order to assure the block ships reaching their destination it was arranged to place a million candle-power calcium flare near the entrance, to be used as a "last resort."

The conjunction of tide and darkness and favorable weather conditions in the evening of May 9, 1918, gave the first opportunity since April 23. Accordingly the force was assembled and the various units left for their stations. An off-shore cover-force of the destroyers *Warwick*, *Whirlwind*, *Velox* and *Trident*, from Dover, took up a cruising station midway between Zeebrugge and Ostend to prevent interference by the German flotilla from the former place. The block ships, their destroyer covering force and the smoke-screen flotilla assembled at Dunkirk. Under the command of Commodore Hubert Lynes, C. M. G., this force got under way in the early evening of May 9 and stood towards Ostend. Shortly after the *Sappho* left her anchorage in Dunkirk Roads, a man-hole joint in the side of a boiler blew out, reducing her speed to six knots and therefore putting her participation that night out of the question.

By 1.30 a. m., May 10, all the preliminary dispositions were completed and the smoke-screen flotillas of motor launches and coastal motor boats were sent in to commence the screen. At 1.35 a. m. no firing had occurred, but a searchlight lit up and commenced to search. At 1.43 a. m. the prearranged signal was given and a heavy bombardment opened up by the monitors' siege guns and airplanes. One division of monitors ran in close enough so that their secondary batteries could also come into action. About five minutes later the Germans commenced to return this fire.

The smoke screen was well laid in a western and an eastern section with a lane between them. While engaged in this work *C. M. B.-24* and *C. M. B.-30* carried out successful torpedo attacks against the pier ends. *C. M. B.-22* encountered a German torpedo boat who turned on her searchlight and opened fire. The *C. M. B.* attacked her with her only armament—machine guns—with such good effect that she was driven away from the harbor entrance.

At 2 a. m. the Germans opened a heavy fire from light guns and machine guns, apparently concentrating most of their efforts in a barrage across the harbor entrance. The inshore force of destroyers fired star shells over the entrance to light up the pier ends for the *Vindictive* and shelled the shore batteries in order to draw their fire and in which they were somewhat successful.

About the same time the *Vindictive* accompanied by *C. B. M.-23*, *C. B. M.-25* and *C. B. M.-26*, left Stroom Bank Buoy close on the port hand and stood towards the harbor entrance for 13 minutes. At this time the darkness and smoke had reduced visibility to about one and a half cable lengths. As the entrance was not sighted she slowed down to nine knots and altered course to the westward, parallel to the shore. Failing to pick up the pier ends, she counter-marched to starboard. This in turn brought no success so she again altered course 16 points to starboard and gave the signal for "the last resort." *C. M. B.-23* lighted a million candle-power flare close inshore to the westward of the entrance. The smoke and fog, which had then settled down, dimmed the effect of the flare so that while it lighted up the piers for the *Vindictive* the small craft remained ill-defined or invisible to the Germans, except at closest range.

The *Vindictive* then became clearly visible to the shore batteries and she was subjected to a heavy fire. However, she had only 200 yards to go and immediately turned for the entrance. At this point her smoke boxes were lighted. Having passed the pier ends close to the eastern side the ship was given full left rudder and the port engine was backed full speed. However, as the port propeller had been damaged against the Mole at Zeebrugge it had little effect. As soon as the ship stopped swinging the sinking charges were exploded and she quickly sank with her bow close to the eastern pier and lying athwart the channel at an angle of about 25 degrees. It had been intended to ram the western pier so that the tide could have assisted in swinging the ship across the channel, but when the *Vindictive* found the entrance she was so close to the eastern pier that swinging her to starboard would probably have caused her to ground broadside on.

In the meantime the *Vindictive's* other two escorts, *C. M. B.-25* and *C. M. B.-26*, had torpedoed the pier ends and attacked them with machine guns. This mission accomplished, they drew off.

As soon as the block ship began to sink *M. L.-254* and *M. L.-276* stood in the entrance, engaging both piers with their machine guns, and went alongside of her to take off the crew. A thorough search of the ship was made and all of the wounded were brought off. During this operation *M. L.-276* was hit in fifty-five places but kept under way, steering to the westward,

until picked up by the *Prince Eugene*. The *M. L.-254* was severely damaged and, on standing out, missed the inshore covering force and was finally picked up by the *Warwick*, of the offshore covering force, at 3.15 a. m. after firing a distress signal.

When all hands had been taken aboard the destroyer the motor launch was sunk and the division of destroyers stood off. By this time the tide had fallen so low that it was inexpedient to return by the route inside of the shoals by which the approach had been made. So the course was set for a gap in the net defence by the deep-draught route from Ostend to seaward.

Evidently the Germans had mined this route in anticipation of an attack, as the *Warwick* struck a mine at 4.00 a. m., which broke her back just ahead of the superstructure of the after superimposed 4-inch gun and destroyed the after part of the ship. She took a heavy list and seemed to be settling by the stern. The *Velox* went alongside and took off all of the wounded. The *Whirlwind* took her in tow and the *Velox* remained alongside to steer her. The division arrived at Dover at 4.30 p. m. The general retirement was well carried out without further casualties.

Results.—The chief mission, the destruction of the Flanders triangle, was undoubtedly well accomplished. Aerial observation showed that the blocking of the entrance to the Bruges Canal had prisoned, in Bruges, many torpedo and submarine craft whose draft prevented them from making their way out through the smaller canals to Ostend. And it was not until late in the summer after a great deal of dredging that a somewhat perilous and narrow channel was opened past the *Iphigenia*.

The position of the *Vindictive* in the entrance to Ostend Harbor, lying at an angle of 25 degrees to the eastern pier, merely restricted the entrance and a sufficient channel was left between her stern and the western pier to allow the passage of any torpedo or submarine craft. So the destruction of the triangle was due in part to the fact that the Ostend-Bruges leg was in reality a negligible quantity due to the shallowness of the canals.

On the other hand the damage to the base of the triangle was almost insignificant. The over-running of the prearranged position by the *Vindictive* at Zeebrugge prevented any damage being done to the Mole itself by the excellently arranged demolition party. The destruction of the viaduct by the submarine *C-3*

undoubtedly caused considerable inconvenience in the communication between the shore and the seaplane base and the batteries on the Mole. Aerial photographs of the defences show that although the battery emplacements were damaged, none of the guns were struck.

To accomplish this mission the English expended the old submarine *C-3* and the old cruisers *Thetis, Intrepid, Iphigenia, Brilliant, Sirius* and *Vindictive*. In carrying out the attack they lost the destroyer *North Star* and motor launches numbers *110, 254* and *424*. Besides, the destroyer *Warwick* and *M. L.-276* were badly damaged. The damages to the rest of the forces employed were slight.

Although the losses were no greater than those suffered by the English Army in undertakings of equal magnitude, the personnel casualties on April 22-23 were heavy: 176 killed; 412 wounded; and 49 missing, of which it is believed 35 were killed. In comparison the losses on May 10 were slight, but a much smaller force was engaged: 8 killed; 30 wounded; and 11 missing, all believed to have been killed. The total casualties for the whole operation were 184 killed, 442 wounded and 60 missing.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

BRINGING IN THE SHEAVES

By COMMANDER CLARENCE NELSON HINKAMP, U. S. Navy

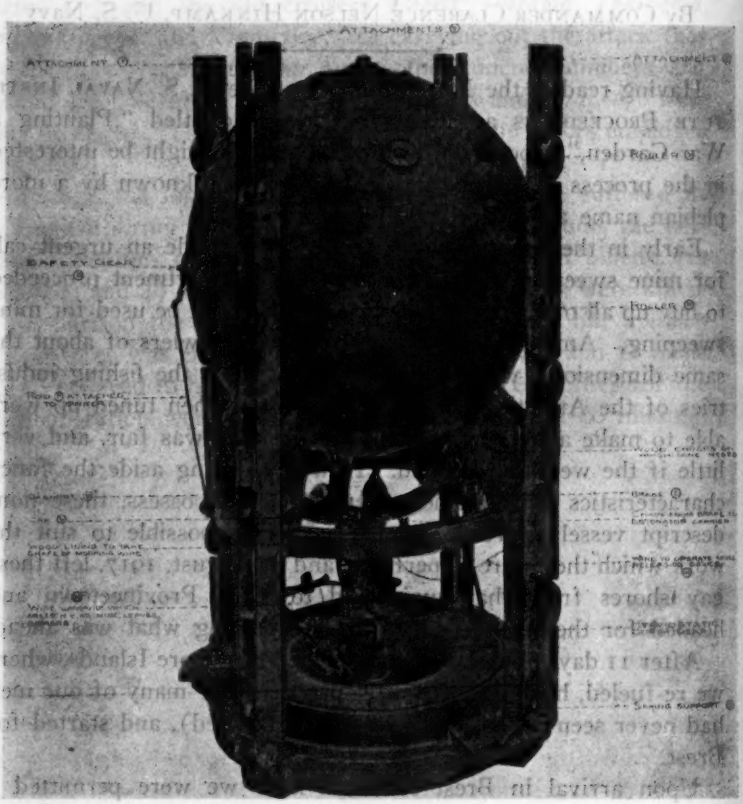
Having read in the March number of the U. S. NAVAL INSTITUTE PROCEEDINGS an interesting article entitled "Planting a War Garden," it occurred to me that several might be interested in the process of "Bringing in the Sheaves," known by a more plebian name as "Mine Sweeping."

Early in the summer of 1917 the Allies made an urgent call for mine sweepers, whereupon the Navy Department proceeded to buy up all of the available craft which might be used for mine sweeping. Among the purchases were ten trawlers of about the same dimensions, which had been engaged in the fishing industries of the Atlantic Coast. These vessels when tuned up were able to make about ten knots if the weather was fair, and very little if the weather was bad. However, laying aside the fancy characteristics which mine sweepers should possess, these nondescript vessels were remodeled as far as possible to suit the work which they were to perform, and in August, 1917, left these gay shores from that quaint old town of Provincetown and headed for the Azore Islands, little dreaming what was ahead.

After 11 days of steaming we reached the Azore Islands, where we re-fueled, held a short target practice (for many of our men had never seen a gun, much less heard it fired), and started for Brest.

Upon arrival in Brest six days later we were permitted a short breathing period, after which we were put upon coastal convoy duty. Due to the fact that the vessels were built of wood, and were about as flexible as a spring and not very easy to handle, it was decided, after one vessel sunk off Ushant, to take the trawlers off convoy duty and convert them into mine sweepers, using the French method of dragging. While the vessels were being fitted out at the arsenal in Brest, the officers were sent out on French mine sweepers to learn the game.

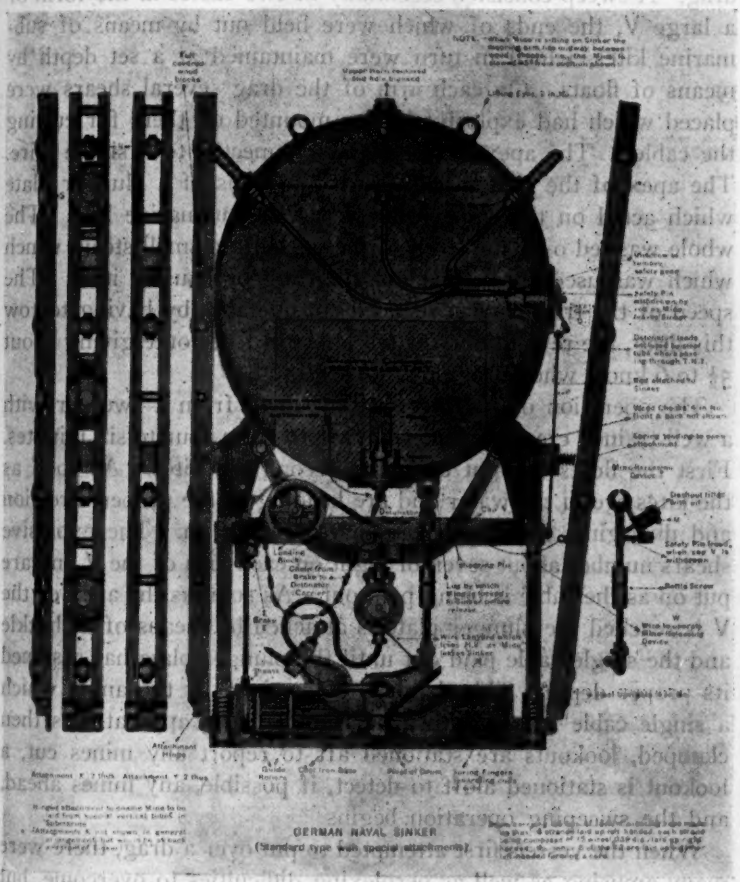
It was my pleasure to spend ten days on a French mine sweeper working on the north coast of France. All convoy routes had been heavily mined so we knew that we would gather some "eggs" We did—a more interesting experience cannot be pictured. It is very pretty to read a description of a fight with a submarine, or a fight with a vessel on the surface, or of sow-



A GERMAN MINE COMPLETE, READY FOR STOWAGE.

ing mines to catch the enemy, but let your imagination run rampant for a few moments and picture an area which is known to be mined, and it is your particular little job to clear the field. It may be that the automatic gear of the German mine did not work, whereupon the mine would float a little too high and the vessel, gently riding on the swells, might, on a downward plunge,

hit one of these small implements of Satan; or it might be that the sweeping gear would foul a mine cable instead of cutting it, and in hauling in the gear the mine might accidentally be hauled up under the ship; or the mine might have been planted with a heavy tide running, and in slack water would be floating with



GERMAN MINE SHOWING DETAILS OF ANTENNÆ AND ANCHOR.

the mine cable upright instead of at an angle. All of these conditions might be met and we knew it.

Again, if the vessel was of too deep draft the factor of safety due to the tide would be decreased by just that much. The only factor of safety that there was in the whole mine sweep-

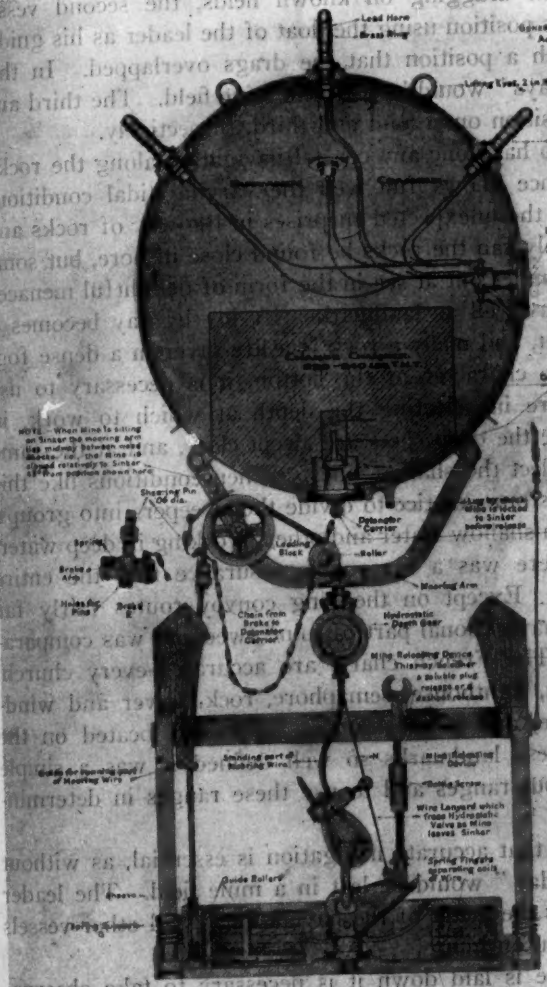
ing operation was that due to the tide, and it sometimes happened when weather conditions were unusual that the tide did not serve in accordance with the rules.

The gear used by the United States vessels in France in mine sweeping is known as the "Ronarc'h drag," or "single ship" drag. A sweep consisted essentially of two cables in the form of a large V, the ends of which were held out by means of submarine kites, which in turn were maintained at a set depth by means of floats. On each arm of the drag several shears were placed which had explosive knives mounted on them for cutting the cables. The apex of the V was connected to a single wire. The apex of the V was held down by means of a plunger plate which acted on the same principle as the submarine kite. The whole was led over the stern of the vessel to a small steam winch which was used for letting out the drag or hauling it in. The speed of the trawler was reduced considerably by having to tow this drag, the revolutions for ten knots in free route giving about 5½ to 6 knots when dragging.

The operation of putting over the drag from a sweeper with a well-trained crew consumes anywhere from four to six minutes. First the floats are put over and second the kites. As soon as the kites are in the water and are heading in the proper direction and diverging, the explosive shears are put on. The explosive shears number about seven or eight on each arm of the V and are put on as the cable is being paid out. As soon as the apex of the V is reached the plunger plate is attached by means of a shackle and the single cable paid out until the plunger plate has assumed its proper depth. This depth is determined by the angle which a single cable makes with a horizontal. The apparatus is then clamped, lookouts are stationed aft to report any mines cut, a lookout is stationed aloft to detect, if possible, any mines ahead, and the sweeping operation begins.

When the vessels first attempted to put over a drag, there were many amusing as well as perplexing difficulties to overcome, but patience and persistence finally won out and the art was mastered.

The formations employed were in general of three kinds: the starboard quarter formation, the port quarter formation and the wedge formation. When sweeping convoy routes on "exploration" sweeping, the wedge formation was generally used. In exploration sweeping the vessels covered a very much wider



GERMAN MINE JUST RELEASED.

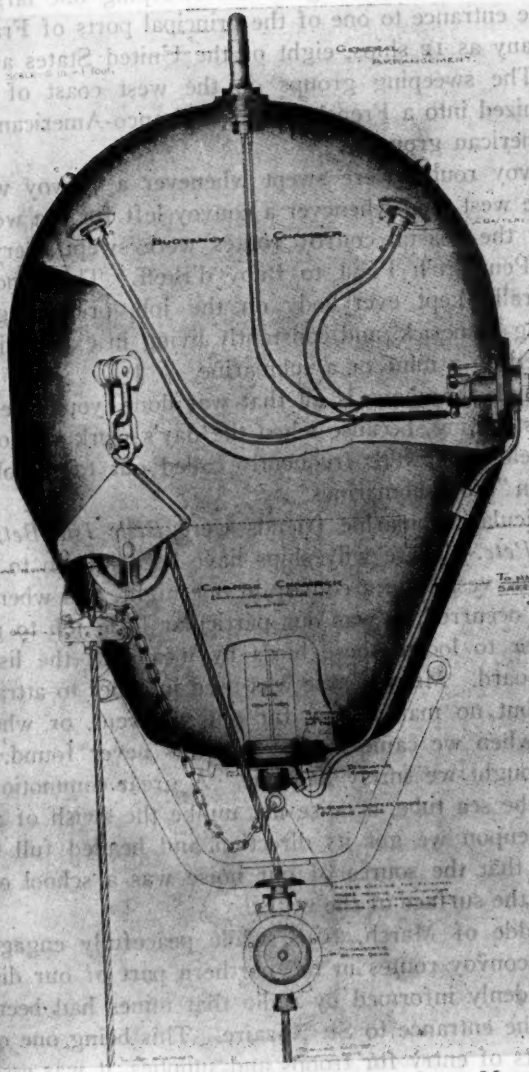
area than when dragging on a known field. Each sweeper could drag a width of about 200 yards. The "quarter" formation was used when dragging on known fields, the second vessel maintaining his position using the float of the leader as his guide, keeping in such a position that the drags overlapped. In this way no "holidays" would be left in a mine field. The third and fourth kept position on second and third, respectively.

Any one who has done any coastal navigation along the rocky shores of France knows full well the varying tidal conditions one meets, and the unexpected surprises in the way of rocks and shoals. Not only can the rocks be found close inshore, but some project several miles out at sea in the form of delightful menaces to navigation, as well as landmarks. A joy by day becomes a menace by night, and many a rock is a life-saver in a dense fog.

Owing to the character of the bottom it is necessary to use considerable care in selecting the depth at which to work, in order to be sure the deep spots are swept clear, and at the same time not to neglect the shallow ones. When conditions like this were met, it was our practice to divide the sweepers into groups, some working in shallow water and others working in deep water. In this way there was a reasonable assurance that the entire area was clear. Except on the long convoy routes fairly far from land, the navigational part of mine sweeping was comparatively simple. The French charts are accurate—every church, hill, house, barn, lighthouse, semaphore, rock, tower and windmill has a name, and its position is accurately located on the chart. With these landmarks so well defined it was a simple matter to pick out ranges and to use these ranges in determining positions.

It is apparent that accurate navigation is essential, as without it many a "holiday" would be left in a mine field. The leader in all cases bears the brunt of the navigation, as all other vessels take their position on him.

When a course is laid down it is necessary to take observations at intervals of about two to three minutes, and accurately plot the position. One soon becomes accustomed to taking bearings, sextant angles, spotting ranges, and laying them down speedily and accurately. By taking readings at short intervals it is simple to detect the set and drift and correct the course in order that the field may be accurately swept.



GERMAN MINE SHOWING DETAILS OF HYDROSTATIC AND MECHANICAL CLAMPS.

The usual number of vessels in one sweeping group when on a mine field is four, although when sweeping one large mine field off the entrance to one of the principal ports of France we used as many as 12 ships, eight of the United States and four French. The sweeping groups on the west coast of France were organized into a French group, a Franco-American group, and an American group.

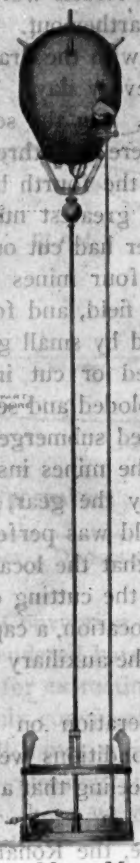
The convoy routes were swept whenever a convoy was due in from the west, and whenever a convoy left for the west, and in addition the coastal convoy routes were swept every other day from Penmarc'h Point to Buoy d'Bœff. This amount of work naturally kept everybody on the job, preventing them from getting homesick, and constantly living in expectation and hopes of getting a mine or a submarine.

If you think the above is all that was done, you have still a few guesses coming, because when the day's work was over on the mine fields, we were frequently called out to patrol areas or "listen in" for submarines.

Our particular submarine friends were *Belle Isle Betsy* and *Penmarc'h Pete*. These wily ships have been known to get as many as three vessels in a convoy in one night, and when these little events occurred, it was our particular little job to go out and endeavor to locate these birds by means of the listening devices on board. Many a ruse was used in order to attract the submarine, but no matter how far out we went, or when we started, or when we came in, the sub was never found. One night we thought we surely had one. A great commotion was heard over the sea tube, a noise not unlike the swish of a propeller—whereupon we got its direction and headed full speed, only to find that the source of our noise was a school of fish playing near the surface of the water.

In the midde of March, 1918, while peacefully engaged in clearing the convoy routes in the northern part of our district, we were suddenly informed by radio that mines had been discovered off the entrance to St. Nazaire. This being one of the principal ports of entry for troops and supplies, it was essential that the channel be cleared at once.

The combined forces of the French and the United States worked on this field. The first mine discovered on the field was picked up by a patrol vessel. The mine was adrift several miles



GERMAN MINE, MOORED.

out. The second mine was discovered several miles from the first by avion. These two mines being so widely separated made the exact location of the mine field difficult, so that it was necessary to use a large number of vessels to explore for the exact location of the field. An area six miles wide and ten miles long was declared dangerous and closed to navigation. This large area had to be completely swept in order to be sure to get the mines. The low-powered vessels worked close inshore while the larger sweepers worked farther out. By figuring very closely on the tides it was possible, with the draft of our vessels, to sweep safely about five hours every day. The first sweep was made and no mines discovered. On the second day of the sweeping operations four mines were cut, three having been cut by one United States vessel and the fourth by a French vessel. Up to that time, three was the greatest number of mines which any one United States sweeper had cut on any one day.

The location of these four mines was such as accurately to determine the line of the field, and for the next week sweeping operations were conducted by small groups of sweepers. In all 12 mines were discovered or cut in that area in one week. Several of them were exploded and several sunk by gun fire and two of them were exploded submerged, the mine-sweeping gear striking the antennæ of the mines instead of cutting the cables. No mines were fouled by the gear, so that the score for the sweepers on that mine field was perfect.

On the particular day that the location of the mine field was accurately determined by the cutting of four mines, we had assisting us in the work of location, a captive balloon, several flying boats, patrol vessels, and the auxiliary vessels which were used to shoot up the mines.

As a spectacle the operation on that day has never been equalled. The weather conditions were ideal and all hands returned to port that night feeling that a good day's work had been accomplished.

For a mechanical device, the Ronarc'h drag, in the hands of amateurs, possesses more peculiarities and queer traits than even the crankiest of cranky automobiles.

The system of signals used was simple. It consisted of signals of formation, signals for putting the drag over, taking it in, and such casualties as one might expect. The signal for cutting the

mine was the tooting of the whistle. When a mine was cut the sweeping division continued on their course as previously planned, the mine being sunk by a small power boat which accompanied the sweeping group. In case no extra vessel was taken along the duty of sinking the mines fell to the lot of the last vessel in formation. He would upon discovering a mine floating, take in his drag and proceed to sink the mine.

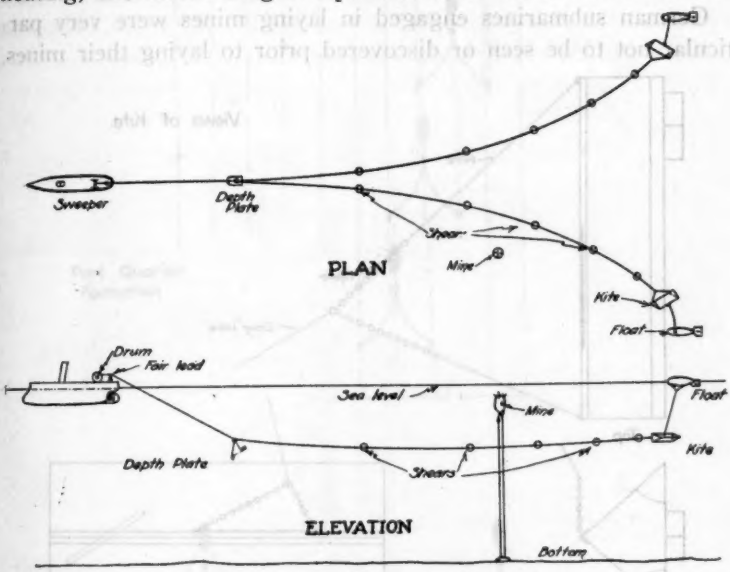


DIAGRAM OF A DIVERGENT SWEEP.

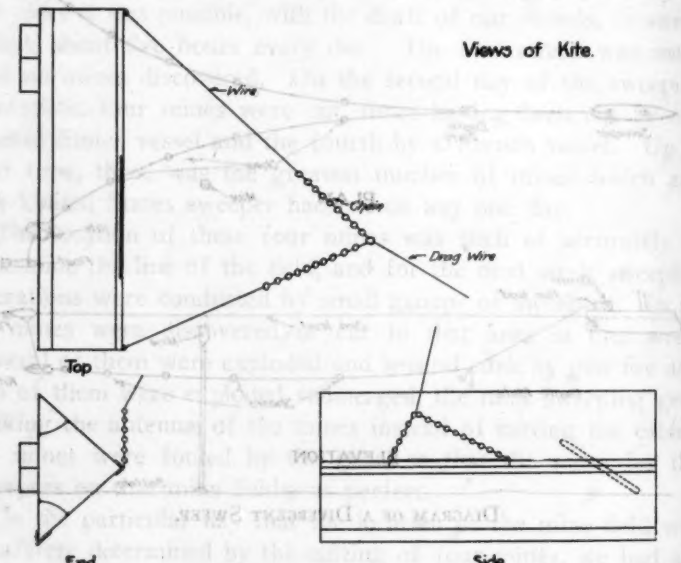
The rules of the Hague Convention required that a mine when it came adrift was to be rendered harmless. The German mines were rigged with a device for extracting the primer when a mine came adrift, but I am firmly convinced that every floating mine was dangerous, because all mines which were captured and examined indicated that the releasing apparatus was not properly attached. Whatever rules there were in regard to mines, the enemy religiously violated them.

It is believed that neutral vessels were engaged in laying mines off the French coast, and it is likewise known that German submarines mostly laid mine fields off the French coast.

The lines of mines were laid usually in the shape of **U's, V's** and **L's,** generally on some well-known navigational range or

within the circles of visibility of more prominent navigational lights along the French coast. Toward the end of the war there was no particular regularity in their methods of laying mines, owing to the fact that their Kultur was either lived down or outgrown to such an extent that the submarine captains dared to exercise a little originality. The mine fields were generally laid by submarines engaged solely in this diabolical occupation.

German submarines engaged in laying mines were very particular not to be seen or discovered prior to laying their mines,

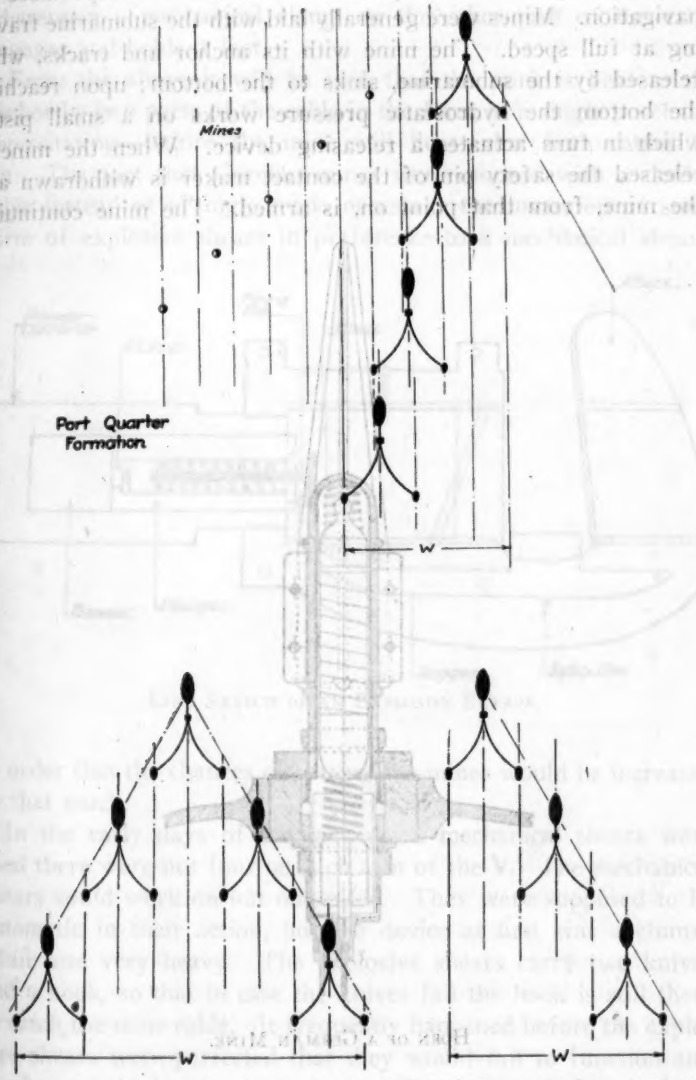


SUBMARINE KITE.

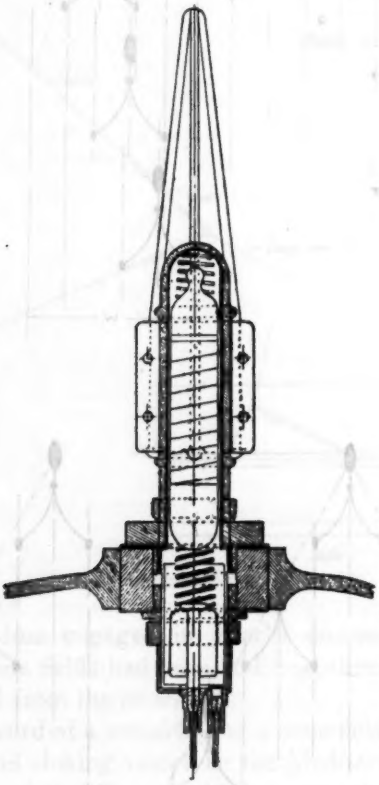
and likewise seldom engaged in attacks on merchant vessels until after the mine fields had been laid, and then generally in a zone far removed from the mine field.

A case is on record of a vessel laying a mine field in the vicinity of St. Nazaire and sinking vessels in the Mediterranean Sea.

The operation of the German mine is entirely an automatic one. The mine with its anchor is a complete unit and is carried in a torpedo tube from which it can be fired, or is carried in a tunnel in the submarine from which it is released. Mines may be laid either submerged or on the surface, the chances being that the majority of the mines were laid with the vessels travelling


Mines
Port Quarter Formation
W
W
W
Wedge Formation
Stbd. Quarter Formation

on the surface rather than submerged, although laying them submerged presented no particular difficulties except those of navigation. Mines were generally laid with the submarine traveling at full speed. The mine with its anchor and tracks, when released by the submarine, sinks to the bottom; upon reaching the bottom the hydrostatic pressure works on a small piston which in turn actuates a releasing device. When the mine is released the safety pin of the contact maker is withdrawn and the mine, from that point on, is armed. The mine continuing

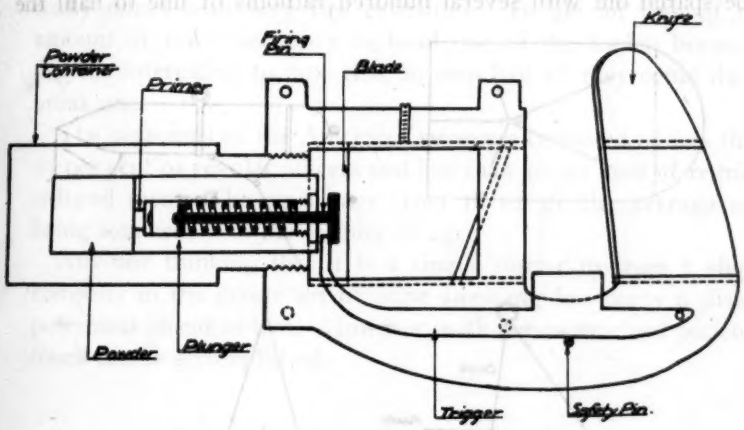


HORN OF A GERMAN MINE.

to rise reaches a point about six to ten feet from the surface of the water, when the hydrostatic clamp gets in its dirty work and holds the mine securely. In case the hydrostatic gear fails the mine will float.

If the part of the cable on which the hydrostatic clamp is working accidentally be cut, the mine will start to rise suddenly, whereupon a mechanical clamp on the other part of the cable engages and holds it fast.

From the above it will be seen that the mine is held to the anchor by two parts of the cable in the form of a single purchase, necessitating—before the mine will float—that both cables be cut. The fact that German mines were moored with a double cable instead of a single made necessary the invention of some form of explosive shears in preference to a mechanical shears,



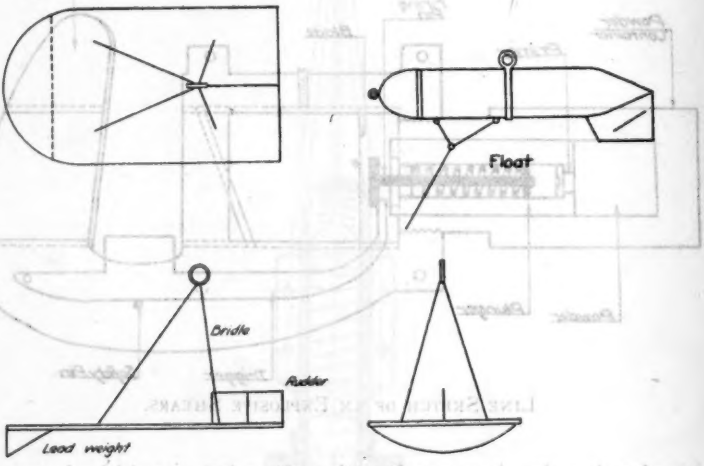
LINE SKETCH OF AN EXPLOSIVE SHEARS.

in order that the chances of getting the mines would be increased by that much.

In the early days of the war when mechanical shears were used there were but four on each arm of the V. The mechanical shears could work on but one cable. They were supposed to be automatic in their action, but the device at first was a clumsy affair and very heavy. The explosive shears carry two knives and a hook, so that in case the knives fail the hook is still there to catch the mine cable. It frequently happened before the explosive shears were perfected that they would fail to function and a mine would be dragged along. The anchor being dragged along as well would bounce from rock to rock over the bottom, finally shearing itself, whereupon the mine might float and easily be sunk.

Again, when the shears failed to function a mine with its anchor might be dragged up close under the vessel, in which case the sweeper would head for the nearest sandy beach, constantly keeping the mine in view but well astern.

Upon arrival in a satisfactory anchorage the dragger would then release the sweeping gear at the apex of the V and permit the entire apparatus to sink. The floats at the kite end being on the surface would be sufficient to mark the spot where the drag and mine was located. The vessel would then proceed to a safe anchorage and at once send all hands of the crew that could be spared out with several hundred fathoms of line to haul the



DEPTH PLATE AND FLOAT.

mine upon the beach where it could be either examined or destroyed, as desired.

In hauling the mine on the beach the float would first be hauled inshore. Next the kite, and as soon as the mine appeared above the surface of the water the long line would be manned and the mine hauled up on the beach. The antennæ or lead horns are the source of danger, because the bending of one of these horns would cause an electric current to be generated, resulting in the explosion of the mine.

If the mine is to be examined, the procedure should be about as follows: First, pull the contact maker out and insert a safety pin; next, unscrew the plate holding the contact maker. This

would expose the electric wires which can then be cut. As soon as the wires are cut out the mine is safe. Next remove the horns and lastly remove the primer. The mine can then be examined at will.

In case it is desired to explode a mine which has been brought up on the beach, two methods present themselves: One, to endeavor to explode it by rifle fire, shooting at the horns; second, to attach a line to the horns and endeavor to break one. Both methods have been used with success.

It is a remarkable fact that the French have examined a great many mines with very few casualties. To get an idea of the amount of force necessary to bend one of the leaden horns, it may be interesting to note that 20 men had all they could do to break one.

The personnel of the American sweepers consisted of less than 10 per cent of regular officers and less than 40 per cent of regular enlisted men. The ages vary from 18 to 56, the average age being somewhere in the vicinity of 23.

Any one thinking that it is a simple matter to train a ship's company in the gentle art of mine sweeping has many a disappointment ahead of him. However, with persistence and patience much can be accomplished.

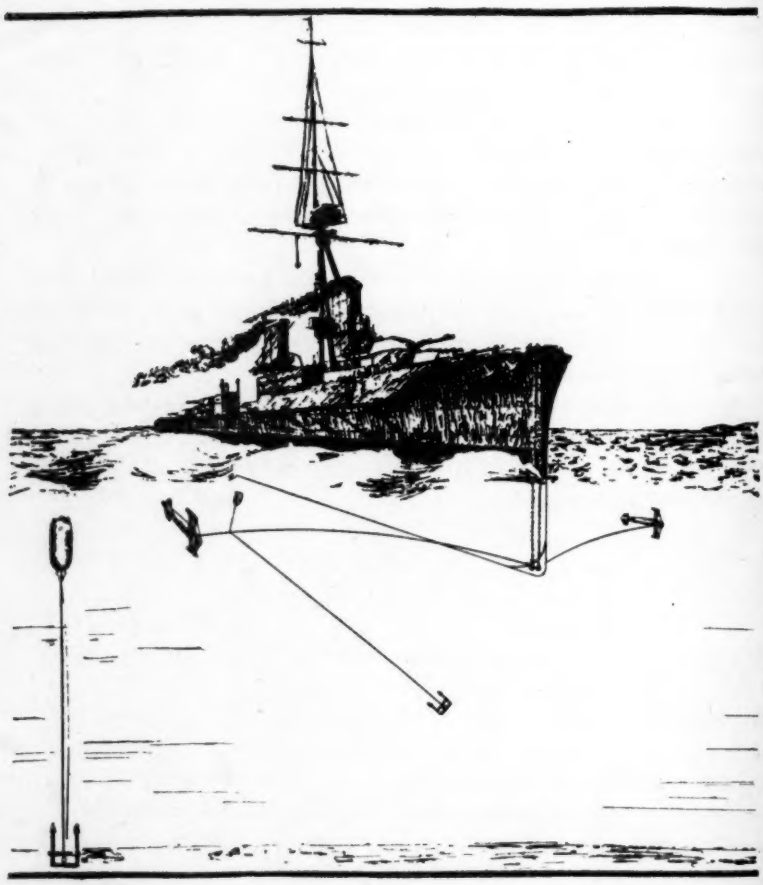


FIG. 1.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

PARAVANES

By LIEUTENANT GEORGE L. CATLIN, U. S. N. R. F.

One of the mysterious and most successful new devices used by the Allied Navies in the war with Germany was the Paravane.

This device was invented and developed by Commander C. D. Burney, Royal Navy, for the protection of ships against moored mines. The very nature of this invention, and the manner of its use made its success dependent to a great extent on the maintenance of secrecy in all matters pertaining thereto. Throughout the war, every precaution was taken by the Allied Navies to keep information regarding paravanes confidential. The instructions of the Navy Department prohibited the use of the word "Paravane" over the telephone or in dispatches, and all the correspondence on the subject was kept in confidential files. Up to the time of the armistice, if the enemy had any knowledge of the nature of this device, he had not succeeded in preventing its successful use.

At the time the United States entered the war, the Bureau of Construction and Repair was experimenting with a device somewhat similar to the paravane, in the model basin at the Navy Yard, Washington. In the meantime, reports had been received from the naval attaché, London, that the British Admiralty were fitting their naval vessels with gear for protection against mines. Therefore, soon after we entered the war, the Admiralty was requested to furnish the Navy Department drawings of this new gear, and permission to use it in case it was found valuable. After considerable correspondence by cable, in May 1917, the Navy Department received definite advice from the Admiralty to the effect that the paravane had established itself as a successful device for protecting ships against moored mines. Further experiments at the model basin were accordingly discontinued, and arrangements were made with the British Admiralty

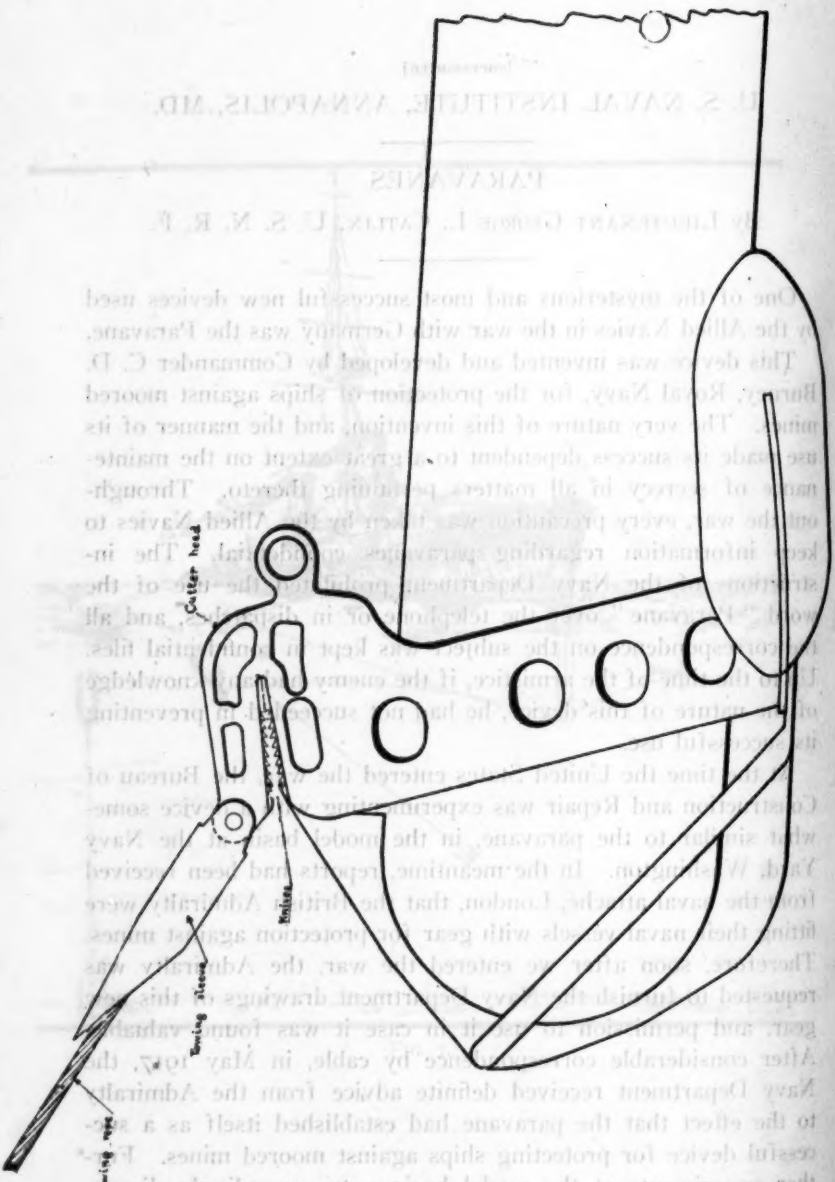

FIG. 2.

for the manufacture of the gear in this country, and for its installation on our naval and merchant vessels.

Principle.—The paravane is in principle an individual mine sweep attached to the bow of the vessel. The general arrangement shown in Fig. 1 is as follows:

From a special fitting attached to the forefoot of the vessel, a torpedo shaped body called a paravane is towed on each side. Vanes and rudders are fitted to this body, which cause it to tow some distance from the side of the ship, and at a fixed depth. A large slightly curved vertical vane, working like a kite, draws the paravane away from the ship. A horizontal rudder with suitable control gear regulates the depth of submergence. The actuating mechanism for controlling the depth will be described further on.

The towing ropes, one for each paravane, attached to the special fitting at the forefoot of the vessel, perform two important functions; the first of these is to tow the paravane; the second is to perform the operation of mine sweeping. As is seen in Fig. 1, these two ropes leading aft and outboard from the stem, form a wedge which encounters the mine moorings and deflects the mine away from the ship toward the paravane. The towing rope is attached to the paravane at what is called the cutter-head, in the jaws of which small saw tooth knives are fitted, as shown in Fig. 2. The mine mooring slides into these jaws, where it is quickly severed, permitting the mine which is buoyant to come to the surface where it can be seen and destroyed.

Three different types of paravanes are used:

Type "M" for merchant ships and other ships of speeds up to 16 knots.

Type "B" for battleships and other vessels of speeds up to 22 knots.

Type "C" for cruisers and other vessels of speeds up to 28 knots.

Depth Control.—All types are about 12 feet long, the spread of the planes being about 7 feet. The size and angle of incidence of the planes vary in the different types, but the principal difference between the type "M" and the other types lies in the depth control mechanism. This control mechanism is somewhat similar to that used in torpedoes. In the "M" type it consists simply of a hydrostatic valve and compression spring,

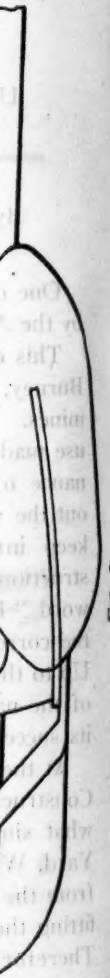

FIG. 2.

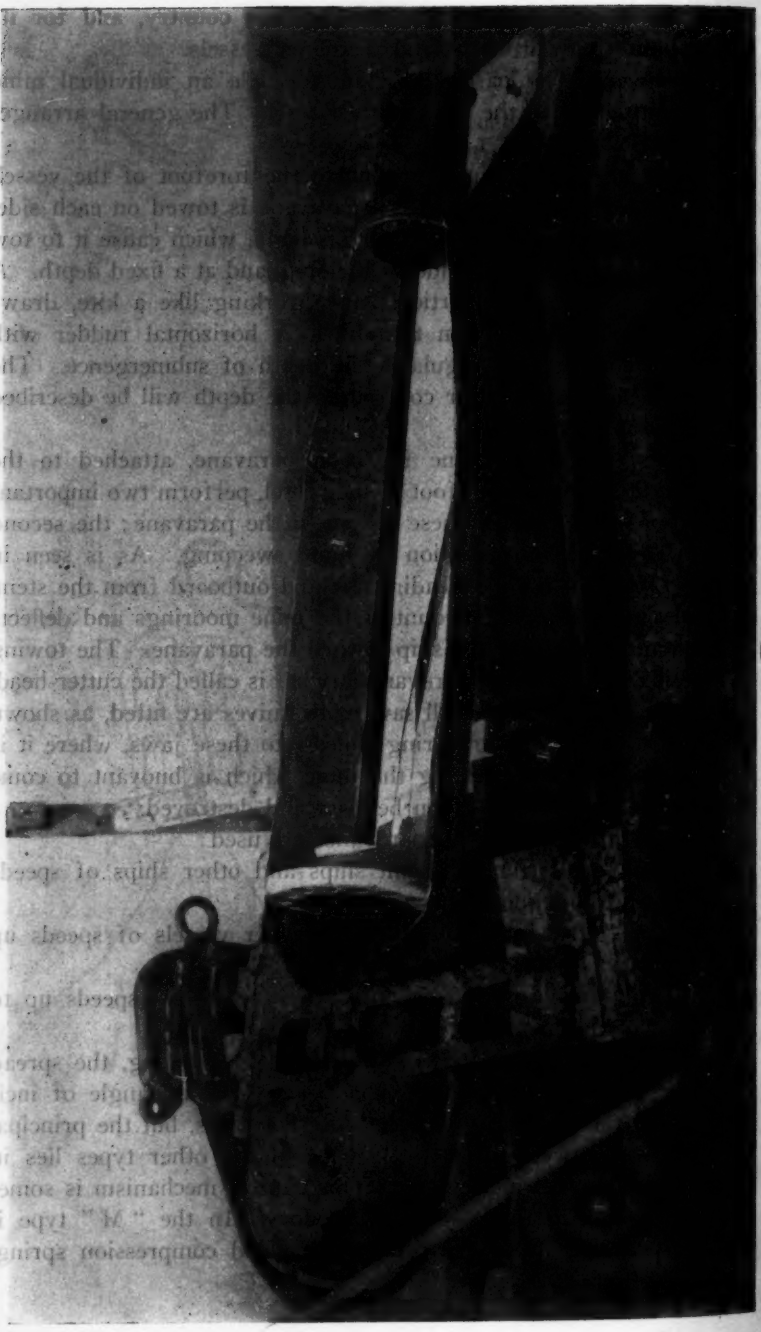

FIG. 3.

located where the tail is attached to the body. The compression spring and hydrostatic valve actuate the horizontal rudder. By regulating the compression spring, the depth at which the hydrostatic valve takes charge is controlled. When the paravane has reached the depth for which the compression spring has been set, the pressure on the valve equalizes the pressure of the spring, resulting in a horizontal rudder. Should the paravane rise above the set depth, the compression spring takes charge, resulting in down rudder and deeper submergence. The opposite action takes place when the paravane has reached too great a depth, causing the hydrostatic valve to take charge.

Oscillator.—Types "B" and "C," designed for higher speed vessels, are fitted with a stabilizer, called the mercury oscillator, Fig. 3, which makes the depth control more sensitive. The hydrostatic valve, being dependent on water pressure for its action, does not respond quickly enough at speeds above 16 knots to prevent large changes in depth above and below the desired running depth. The purpose of the mercury oscillator is to prevent this porpoising action. The oscillator consists of a tube of mercury about 6 feet long, fitted with a valve or diaphragm at each end. Each oscillator contains about 45 pounds of mercury, which exerts a considerable pressure against either diaphragm. A shaft extends from the compression spring in the forward end of the paravane, through the mercury tube to the rudder shaft, and to this main shaft are attached the mercury tube with a valve at either end, and the compression spring directly forward of the forward valve. Just aft of the after valve lies the hydrostatic valve at the point where the tail is attached to the body. It will be noted that the holes in the tail allow the water to come in contact with the hydrostatic valve.

When the paravane is level, the two mercury valves are subjected to the same pressure, and, therefore, no rudder action takes place. The instant the paravane starts to dive, the pressure is increased on the forward valve, resulting in up rudder before the hydrostatic valve has begun to act. In the same way, when the paravane starts to rise, the pressure on the after valve is increased, resulting in down rudder. In this way, the mercury oscillator anticipates the action of the hydrostatic valve, which results in a much more sensitive depth control.

FIG. 3.

Because of the heavy stress, about 6000 pounds in the case of a vessel moving at a speed of 18 knots, and the severe vibration to which the towing ropes are subjected, the British Admiralty found it necessary to use wire rope of special construction for this purpose. The production of suitable rope in the United States presented some difficulties at first, but these difficulties were satisfactorily overcome by John A. Roebling Sons Company.

The similarity of paravanes to torpedoes and the urgent necessity for early production practically limited the manufacturing field to concerns experienced in the manufacture of torpedoes. The maintenance of secrecy prevented advertising for bids in the usual manner. Two bids were secured, however, the bid of the E. W. Bliss Company, Brooklyn, the principal torpedo manufacturers in this country, submitting the lower bid. A contract for several hundred of each type of paravane was accordingly awarded to this concern.

In the meantime, such information as had been received from England regarding deck fittings and under-water fittings was forwarded to the various navy yards, and the yards were requested to prepare designs for the installation of paravanes on battleships and cruisers.

In October, 1917, the writer having already been assigned to duty in connection with paravanes, under the Bureau of Construction and Repair, was ordered abroad to make a study of the subject, with the view of starting the Bureau's organization for this work.

British Organization.—The British Admiralty at this time had established a separate department at Portsmouth Dockyard, called the paravane department, consisting of a total personnel of over 300, including 71 officers. This organization had charge of the design and installation of the special fittings required in connection with paravanes, the manufacture, inspection and testing of paravanes, and the training of personnel in the use of paravanes. Before the writer returned from this trip, the Admiralty stated that one battleship, five cruisers, and twenty merchant ships had cut German mines with their paravanes. In addition to saving these ships, the cutting of these mines had led to the discovery of mine fields hitherto unknown. In consequence, the Admiralty had ordered all British naval vessels, and

all British merchant ships of 12 feet draft to be equipped with this device as soon as possible.

When the writer returned to the Bureau in January, 1918, it was decided to establish a section called "Protective Devices" under the Maintenance Division of the Bureau, to organize and direct all activities in connection with paravanes. Briefly, the work to be done consisted of the following:

1. Preparing instructions and drawings for fitting paravanes to naval vessels.
2. Preparing instructions and drawings for fitting paravanes to Emergency Fleet Corporation vessels.
3. Selecting and equipping a vessel for testing paravanes.
4. Establishing and equipping a shore station for testing paravanes.
5. Organizing and instructing the testing ship personnel.
6. Preparing a confidential handbook.
7. Selecting and fitting out a PV. instruction ship.
8. Organizing the instruction personnel and laying out a course of instruction.
9. Organizing an inspection force for the inspection of PVs in course of manufacture.
10. Organizing an inspection force to inspect Emergency Fleet vessels being equipped with PVs.

Plans for Naval Vessels.—The various naval vessels were listed, and the scheduled dockings charted so that the installation on each vessel could be anticipated by the Bureau, and the necessary instructions issued in advance to the navy yard at which the vessel was to dock. The system adopted was to have each navy yard prepare a design of the under-water fittings and general arrangement for each vessel in general accordance with the type plans sent out by the Bureau. Blue prints of the plans for each vessel were forwarded to the Bureau for examination and approval, but the navy yards were authorized to proceed with the work in advance of this approval, in order to save delay. The Bureau arranged for the purchase, in quantities, of certain special fittings, common to all naval vessels, and allotted a certain number to each yard to be reserved for paravane gear. Special forms were prepared and sent to the navy yards on which they reported every two weeks the status of the paravane work on each ship. This information as received was entered on a

progress card for each vessel. Also record books were started in connection with paravanes and towing ropes and a policy established of controlling the assignment of paravanes direct from the Bureau. No vessel was allowed to receive paravanes until the Bureau was satisfied that her installation of fittings was complete and in working order.

Plans for Merchant Ships.—The Secretary of the Navy having advised the Emergency Fleet Corporation to equip their vessels with paravanes, requested the Bureau to furnish the Corporation with information as to how they should proceed. Several conferences were held for this purpose, and all the drawings and necessary directions were prepared and furnished to the Fleet Corporation.

In this connection, the use of the word "otter" should be explained. The British Admiralty, at the time the fitting of British merchant ships was started, decided that it would be inadvisable to use the technical word paravane in the merchant marine, and chose the word "otter," to be used as the name of the device in connection with merchant ships. As merchant ships usually use type "M" paravanes, these were commonly called otters, while the "B" and "C" types were called PVs. This policy was followed out rigidly in the British Paravane organization, in fact very few captains of merchant ships ever heard of the word paravane, always referring to the device by the name of "otter," or "otter gear."

In accordance with this policy, the United States Navy has used the words "otter," and "otter gear" in connection with merchant ships, and in naval work the abbreviation PV.

The Fleet Corporation, therefore, under advice of the Navy Department, organized an otter gear department to take charge of the fitting of their vessels. The Bureau, at the same time, arranged for the purchase of an additional supply of otters, towing-ropes and inhaul-ropes to be used in the equipment of the Emergency Fleet Corporation ships.

Selection of Testing Ship.—Although torpedo boats were used by the British Navy for paravane testing vessels, it was believed by the Bureau, that some fast yacht might do the work, and the U. S. S. *Winchester* (Fig. 4), a converted yacht of 30 knots speed, was assigned to this work and ordered to the Norfolk Navy Yard, where she was fitted with the necessary gear.

Shore Testing Station.—At the same time, a location for a testing station was found at Yorktown, Va., where the necessary deep water, available dock, and desirable secrecy were combined. A layout for a railroad, derricks, shop and other equipment on the dock were designed, and arrangements made with the Bureau of Yards and Docks to have the work on this equipment started at once.

Purpose and Operation of Testing.—As the *Winchester* was being fitted out, her commanding officer, Lieutenant W. I. Frost, U. S. N. R. F., was given instructions in the operation of testing, and the complement of the ship was increased to carry on this work.

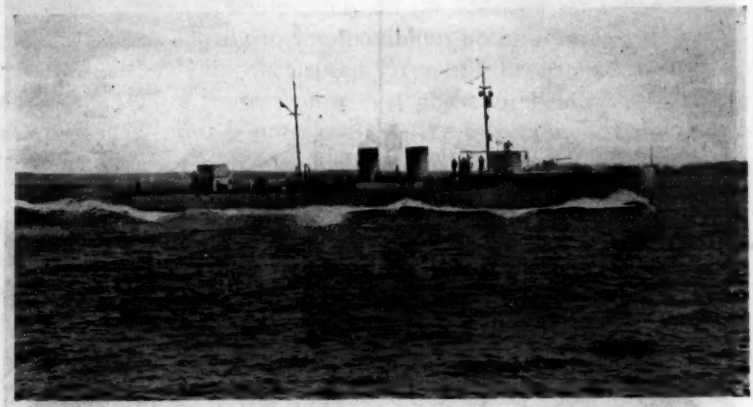

FIG. 4.—U. S. S. *Winchester* S. P. 156, Towing 22-Knot Otters.

The purpose and method of testing will now be briefly described.

As previously stated, paravanes contain a mechanism for controlling the depth at which they travel. British experience had proved that even the most careful shop inspection of a paravane would not determine whether it would run smoothly at its proper depth or not. It was, therefore, necessary to test each paravane by towing it in the water under practically the same conditions under which the paravane would be used. The only difference in these conditions is the point from which paravanes are towed. In service, they are towed from the forefoot of the vessel, while in testing they are towed from the after deck.

A starboard and port paravane are tested at the same time. Paravanes are manufactured port and starboard, the principal difference being the position of the rudder and also the weight and float on the ends of the plane. The weight is always on the lower end and the float on the upper end of the plane when running. The object of the weight is to cause the plane on the paravane to lie in a nearly vertical position when at rest on the surface so that when the ship starts to pull, it will at once start out from the side of the ship. The rudder, by having up helm, will cause the paravane to submerge at the same time.

FIG. 5.—U. S. S. *Winchester* S. P. 156, View from Paravane Inspector's Observation Post, Towing 22-Knot Otters.

Fig. 5 shows the two paravane towing ropes leading from the stern of the testing ship *Winchester*. By measuring the angle at which each towing rope cuts the surface of the water, the depth and variation in depth of the paravane are determined.

The freeboard of the vessel at the stern forms the base of a right angle triangle, one side of which is the surface of the water. The towing rope is the hypothenuse. Fathom and half fathom marks are attached to the towing rope so that the distance on each rope from the chocks to the water may be easily determined by the eye of the observer. The base and hypothenuse being known, the angle required is figured. A certain correction is applied to

the starboard and a different correction is applied to the port rope for the reason that, due to the twisting action of the water on the wire rope, the starboard rope hogs and the port rope sags, as will be noticed in the photograph.

Each paravane is tested at the maximum speed for which it is to be used in service. Type " M " paravanes are tested at 16 knots; type " B " at 22 knots; type " C " at 25 to 28 knots.

The operation of testing is carried out as follows:

The paravanes are inspected carefully at the testing station on the dock and set to run at 20 feet depth. They are then put overboard and towed out to the testing ship by launches, a port and starboard paravane being delivered at the same time. The testing ship proceeds immediately on the testing course, increasing her speed gradually to the maximum necessary for the type under test, and holding that speed for a full three minutes. If a paravane oscillates more than 5 feet above or below the depth for which it is set, it is not passed by the inspector. At the end of the test the ship is stopped and the paravanes are hauled in and made fast on either side of the ship, close inboard. The ship then returns to the station, lets go the two tested paravanes and picks up a fresh pair from the launches. An inspection slip, showing the record of each tested paravane is delivered to the launch with the paravane so that the record of each paravane is returned with it to the testing station. Under ordinary conditions the testing ship tests a pair of paravanes every 20 minutes.

When a paravane has passed test and is ready for service, a history sheet for that paravane is started. On this sheet is recorded the serial number of the PV. and the adjustments made by the testing station to make it run properly. The history sheet follows the PV. wherever it is shipped. Each transfer and each adjustment of rudder is recorded on this sheet.

Each paravane when shipped from the testing station is set to run at a depth of 20 feet. Instructions are given for each ship to reset her paravanes to run at a depth of 5 feet below her own draft. Vessels drawing over 30 feet, however, are instructed to set their paravanes to run at a depth of 35 feet.

Confidential Handbook.—As it was considered necessary that each vessel being fitted with paravanes should have a book containing full information as to theory, construction, maintenance and operation of paravanes, the Bureau proceeded to compile and

published a confidential handbook called the " PV. Handbook " for the use of naval officers. A copy was forwarded to the commanding officer of each battleship, cruiser and transport, the Bureau requiring a signed receipt for each. At the same time, another handbook called the " Otter Gear Handbook " was compiled, containing information necessary for merchant ship captains, and copies of this book were furnished to the Emergency Fleet Corporation for distribution to their vessels.

Selection and Equipment of Instruction Ship.—As it was necessary to have an instruction ship to train merchant ship captains, as well as naval officers, the Bureau suggested to the Fleet Corporation that they furnish a vessel for this duty, the navy to operate her and direct the course of instruction. The Corporation accepted this suggestion, and the steamer *Berkshire,* of the Merchants and Miners Line, was offered. As this vessel was not fit for overseas transportation, and yet was of sufficient size to make her a suitable ship to operate paravanes, she was accepted. The Emergency Fleet Corporation commandeered the ship and started at once to install, under the supervision of the Bureau, the necessary gear to make her a paravane instruction ship.

At the same time the Navy Department commandeered a small gasoline oyster boat called the *Bivalve,* and fitted her out as a mine layer to work in connection with the instruction ship.

As shown in Fig. 1, it is necessary that PVs. be towed from the forefoot of the vessel, this being the apex of the wedge formed by the towing ropes. To meet the conditions required by different types of ships, three different devices for towing paravanes were developed. All three of these devices were fitted to the *Berkshire,* so that the captain of any ship could receive instructions on the particular device he would have to operate.

These will now be described:

In Fig. 6 is shown the bow of the *Berkshire* with the three devices attached. All have the same purpose, namely, to carry the forward ends of the towing ropes down to the forefoot of the vessel as close to the base line as practicable. As the towing ropes have a limited life, each device is constructed so that it can be hoisted or lowered for replacing ropes while the ship is under way.

The first device, used quite generally on battleships, cruisers and transports, is called the clump and chain. This consists of

two chains leading from the deck through chocks on the bow down through holes in the so-called clump or skeg, returning to chocks on the other side of the bow. The towing ropes are attached to a special swivel connection on the chains, and then hauled down close to the hole in the skeg. The towing point is

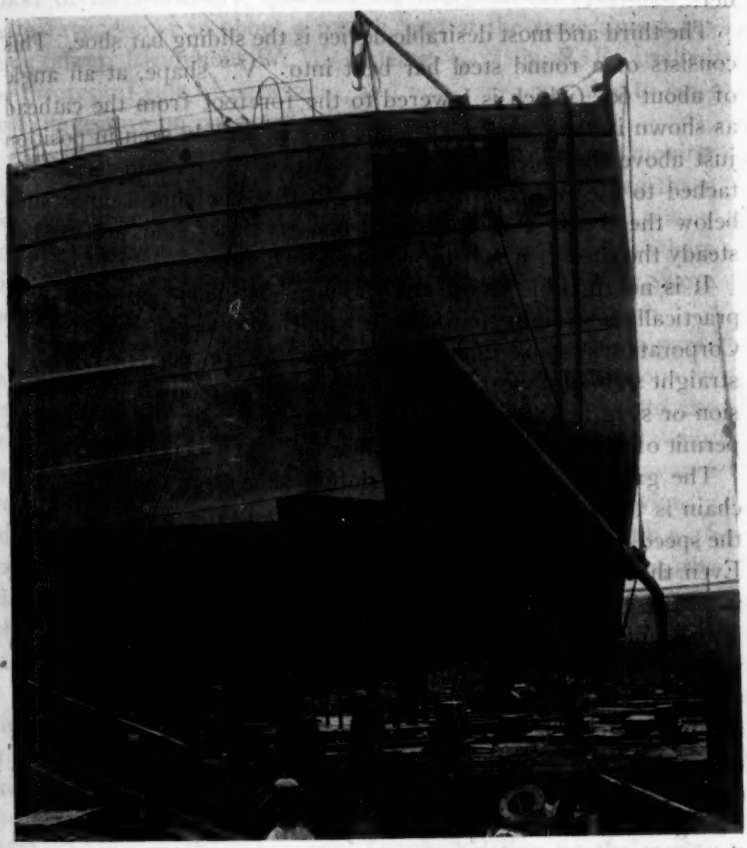

FIG. 6.—S. S. *Berkshire.*

hauled down on either side by hauling up the chain on the other side of the bow.

The second device is called the boom device, developed for use on merchant ships of speeds under 14 knots. As is seen in the figure, the boom when in its down position reaches practically to the base line. It is prevented from swinging further down than

this point by a clip which engages the stem. To the end of the boom are attached the towing ropes. When not in use, the forward end of the boom is hoisted to an almost vertical position and lashed to the deck at that point. The principal advantage of the boom is that it may be attached to a ship without docking her.

The third and most desirable device is the sliding bar shoe. This consists of a round steel bar bent into "V" shape, at an angle of about 60°, which is lowered to the forefoot from the cathead as shown in the figure. The shoe may be plainly seen in position just above the holes in the skeg. A preventor chain is also attached to the cathead of such length that the shoe cannot slide below the skeg. Two backhauls, one on either side, are used to steady the shoe as it is being lowered or hoisted.

It is not feasible to use the sliding shoe except on ships with practically a straight stem. As it happened, the Emergency Fleet Corporation's ships under construction were designed with a straight stem and most of them required only a small stem extension or skeg to extend the straight stem down to the keel line to permit of the use of the sliding shoe.

The great advantage of the sliding shoe over the clump and chain is the fact that there are no chains in the water to retard the speed of the vessel, except when the paravanes are being used. Even then there is only one chain for the shoe as against four in the case of the clump and chain.

In connection with the operation of paravanes there are also required suitable davits or derrick booms of sufficient strength to take a four ton load. These are used in launching and picking up paravanes. Winches of reasonable speed and power are also necessary, as well as certain special fittings which will be described later on.

Organization and Operation of Instruction Course.—When the arrangements were being made to organize the instruction force, including the operation of the *Berkshire,* a difficult situation arose in regard to a commanding officer qualified to operate paravanes and instruct personnel. At that time no American naval officer, outside of the Bureau's representative, had had sufficient experience with paravanes to enable him to conduct the instruction course, including the operation of the paravanes. However, one American ship, the *New York,* of the American

Line, had been fitted with paravanes in Liverpool some months previous, and by special arangement with the Bureau of Navigation, her chief officer, Lieutenant H. R. Lewis, N. A. R., was called into active service temporarily for this duty. Under his instruction, Lieutenant C. C. Jones, the former commanding officer of the *Berkshire,* qualified for the practical operation of the paravane gear in about a month, and at the same time a reserve officer, Lieutenant W. W. Nutting, U. S. N. R. F., studied the theoretical side of paravanes, and was very soon able to conduct the lecture on paravanes on the instruction ship.

A lecture room was fitted up on the *Berkshire,* and a moving picture machine was installed for the purpose of exhibiting three moving picture films showing the manufacture, testing and operation of paravanes. These confidential films, taken by Vickers Limited in England, by arrangement with the Admiralty, were secured by the Bureau through the naval attaché at London.

The daily course of instruction consisted of a lecture on paravanes, exhibition of moving picture films, and instructions in setting paravanes for depth. Then the class proceeded to the deck where the operation of the three different types of towing devices was conducted and explained. Finally, the paravanes were launched and the vessel bore down on two mines previously laid by the mine layer *Bivalve,* which were promptly cut with the paravanes. The vessel was then headed for her base, the paravanes were picked up and the towing points hoisted up by whatever device the *Berkshire* was using at the time. Also any part of the operation not clear to any of the class was repeated.

The description of the operation of paravane gear will not be given in detail, for the reason that actual instruction on a ship is necessary before the gear can be successfully handled. There are four separate parts in the operation: First, lowering the towing points to the forefoot; second, launching the paravanes; third, picking up the paravanes; fourth, hoisting up the towing points. The lowering and hoisting of the towing points have already been briefly described in connection with Fig. 6.

The launching is the difficult operation, as it is always desirable to launch paravanes with the least possible interference with the speed of the vessel. The important factor in launching is the control of the slack in the towing rope. Before launching, the towing rope is led from the forefoot to an easing out hook at

the rail, about 75 feet from the stem, thence to a carpenter's stopper and thence to the paravane on deck. The carpenter's stopper is a special clamp which grips the towing rope without damage to the rope, its purpose being to prevent too much slack from being dragged forward by the pull of the water on the towing rope. The paravane is hoisted by the inhaul rope from the deck, and swung outboard ready to lower into the water. The carpenter's stopper is then released. Then the paravane is lowered to the water and the inhaul rope slacked off very fast, the paravane then towing from the easing out hook at the rail. When the paravane is seen to be running steadily, the easing-out hook is slacked off gradually until it reaches the water's edge. At this point the easing out hook, a specially constructed releasing hook, is tripped, and the paravane then tows direct from the forefoot in its proper position.

The method of launching used on merchant ships requires a vessel to reduce her speed to about 7 knots to get her paravanes safely into the water. The reason for this is the position of the planes of the paravane when they strike the water. The inhaul rope referred to above is attached to an eye back of the cutterhead, and when lowered by this eye the planes of the paravane are practically parallel with the water. As they strike the water in this position, quite often the force of the water will turn the paravane in toward the ship instead of away from it. When this occurs, it is necessary to hoist the paravane out of the water and launch it again.

To obviate this trouble, naval vessels are usually fitted with a special pendant and releasing hook for dropping paravanes in the water. This hook is attached to an eye on the paravane near the center of gravity, but so located as to give the paravane just the right tilt as it enters the water. By this method, the force of the water always catches the right side of the planes and the paravane immediately proceeds down towards its proper position. Naval vessels with this gear are able to launch their paravanes at a speed of 12 knots.

On American ships, picking up paravanes is a comparatively simple operation, but requires that the speed of the ship be reduced to about 7 knots. Even at this speed, the operation puts a severe strain on the winch and derrick with which the paravane is hoisted. The inhaul rope leading over the same derrick

by which the paravane is launched, is hoisted slowly until the paravane reaches the surface of the water. At this point the speed of the winch is increased, so that the paravane is hoisted quickly up to the head of the derrick. British naval vessels, however, do not use an inhaul rope and, therefore, have to heave up the towing points first, then under-run the towing rope with a line attached to the derrick. By this line, the paravane is tripped clear of the water, after which another line is hooked on to the paravane for hoisting it on board. This method requires that the derrick from which the paravane is tripped be placed at a definite distance from the stem of the ship.

When the *Berkshire* was ready for operation, a base for her was established at City Island, near Pelham Bay Camp. This location brought her within easy reach of New York City, and also gave her a deep water course in which to operate. The schedule followed was to send the *Bivalve* out into Long Island Sound, some time ahead of the *Berkshire*, to lay the two mines. The *Berkshire* followed slowly, and by the time the lecture had been completed, and the operation of launching paravanes had been exhibited, she would reach the mines and cut them.

The otter gear instruction office was established in the office of the superintending constructor, New York City, to which all officers and men ordered to take the instruction course were required to report for identification and vise of orders before they were allowed to go aboard the *Berkshire*. Each man was also required to sign a register on board the *Berkshire*.

Inspection of Manufacture.—As the information secured abroad showed that the greatest care must be taken in the manufacture and inspection of paravanes, an inspection force was organized with headquarters at the superintending constructor's office, New York City. Several inspectors were assigned to the E. W. Bliss Works, and several were sent to the principal subcontractor, the Bossert Corporation, Utica, New York. This inspection force not only had to watch the detailed manufacturing with great care, but it developed that due to the great rush of government business of all kinds, the matter of priorities had to be carefully followed up by the inspectors to prevent delay in the shipment and delivery of raw materials to the contractor. To the credit of the inspection force, it should be stated that the first paravanes of each type manufactured in this country passed

the service test on the first run, and the percentage of failures was very small compared to the percentage of failures of British paravanes tested in this country.

Lieutenant Joseph F. Edwards, U. S. N. R. F., was placed in charge of this organization, and most of the credit should be given to him. He worked faithfully, and with unceasing activity up to the time of his sudden death from pneumonia following influenza on October 13, 1918. As an example of his devotion to duty, up to the end he continued to direct the work from his death bed, and finally when he became delirious he continued to talk of paravanes.

Inspection of Merchant Ship Installations.—As previously stated, the fitting of the emergency fleet vessels with otter gear was started under the advice of and carried on under the supervision of the Navy Department. The Bureau, therefore, organized an inspection force to inspect otter gear on Emergency Fleet Corporation vessels, during the construction and after completion, to be sure the gear was properly installed and in workable order. The chief inspector was established in the office of the superintending constructor, and inspectors were stationed at Norfolk, Philadelphia and Cleveland. A detailed report on each inspection was forwarded direct to the Bureau.

The entire paravane organization, under the direction of the Bureau, including personnel on the testing ship and instruction ship, contained 27 officers, and 231 men.

New Launching Hook.—The daily operation of the instruction ship gave an opportunity for making experiments in launching paravanes. The method in use by merchant ships, already described, required a ship to slow down to 7 knots to launch her otters, making her at the time an easy target for submarines. This was due to the fact that the plane being in horizontal position would often catch the force of the water on the wrong side and drive the paravane into the ship's side. Fig. 7 shows the paravane being launched according to this method as established by the British practice. It will be noted that the plane in this picture is practically horizontal.

The Bureau by experiments developed a launching hook attached to the body of the PV. through which the inhaul rope is led, giving a tilt to the plane, as shown in Fig. 8. This hook is so designed that it holds the inhaul rope firmly when under

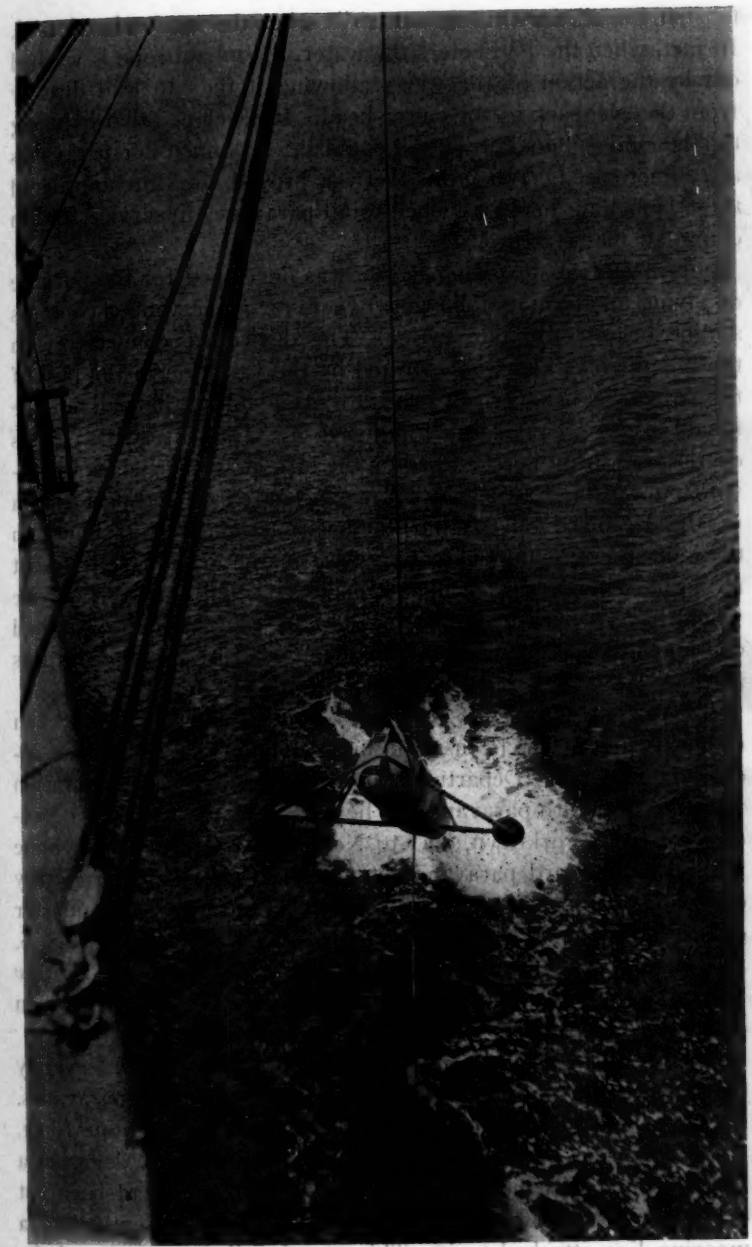

FIG. 7.

tension, but allows it to slip out easily when the tension is released. In fact, when the PV. enters the water, the inhaul rope is washed out by the action of the water allowing it then to lead directly from the eye, back of the cutter-head. It developed that by using this launching hook any vessel could safely launch her paravanes at 12-knot speed. When this fact was proved, the Bureau ordered these launching hooks attached to all paravanes in service, and in course of manufacture.

Alarm Device.—Another device was developed for the purpose of giving an alarm on the bridge whenever a paravane encounters a mine, or any other obstruction. This device was connected with the inhaul rope, and was operated by the variation in the pull of this rope. Whenever a paravane cuts a mine, the pull on the inhaul rope is considerably reduced for a few seconds. This decrease in strain is registered on the bridge, so that when a paravane cuts a mine an alarm bell rings, and if on the port side a red light, and if on the starboard side a green light shows on the indicator. As undoubtedly a great many mines have been cut at night without any evidence, it is believed that this device would have proved to be of considerable value. If the war had continued, it was intended to equip a number of vessels with this alarm.

U. S. Battleship Cuts a Mine.—On September 7, 1918, an event occurred which justified in itself the entire expense incurred by the Navy Department and Emergency Fleet Corporation in connection with paravanes. The U. S. S. *South Carolina*, proceeding from Yorktown, Va., to New York, cut a German mine with her starboard paravane about 6 miles off the New Jersey coast. The mine came to the surface off the starboard quarter of the vessel, and was seen not only by the officers on the U. S. S. *South Carolina*, but by the officers on watch on the U. S. S. *New Hampshire*. The latter vessel, following the *South Carolina* in column, sheered out to avoid the mine on the surface.

The *South Carolina* would undoubtedly have been severely damaged, if not sunk, if she had not been protected by paravanes.

In the same month the U. S. S. *Quinnebaug* of the mine force, while operating in the North Sea loaded with mines, deflected a floating mine with her port paravane. This mine had been cut or had broken loose from its moorings, but apparently had a mooring line attached to it. This mooring line encountered the

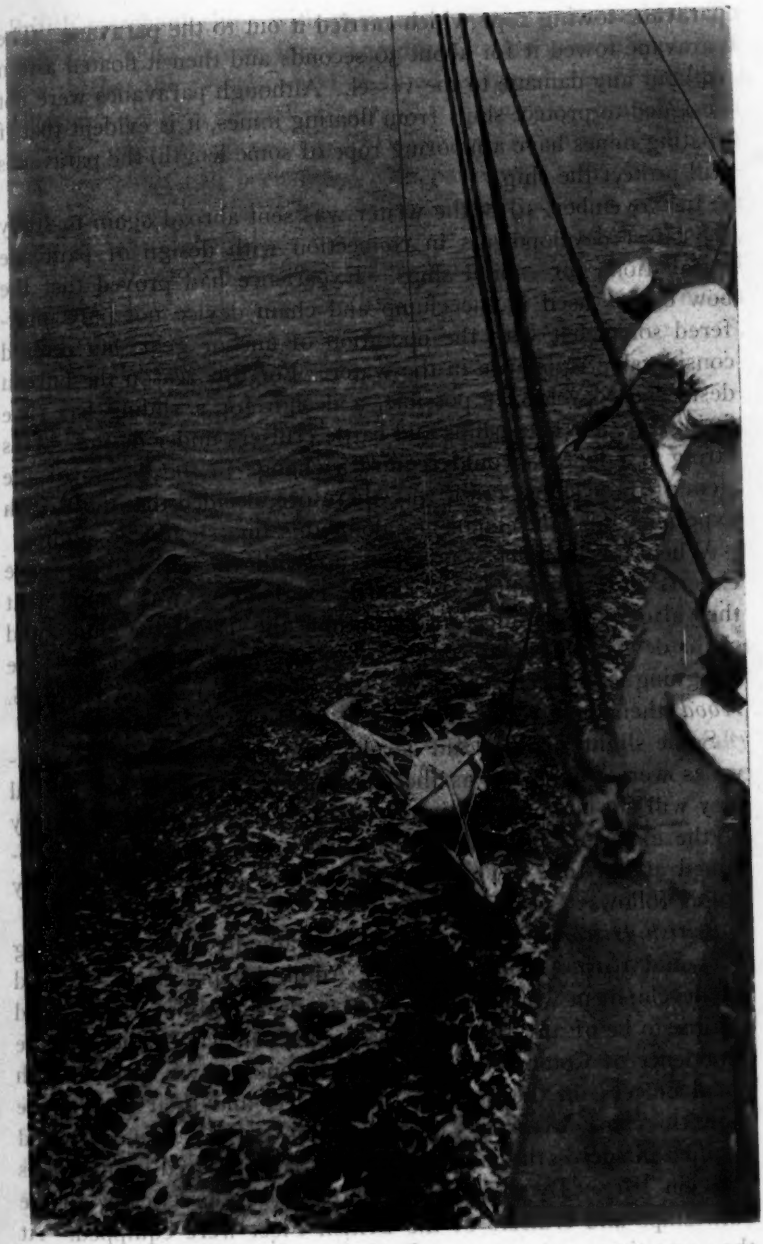

FIG. 8.

paravane towing rope which carried it out to the paravane. The paravane towed it for about 30 seconds and then it floated astern without any damage to the vessel. Although paravanes were not designed to protect ships from floating mines, it is evident that if floating mines have a mooring rope of some length, the paravanes will protect the ship.

In November, 1918, the writer was sent abroad again to study the latest developments in connection with design of paravane installations for capital ships. Experience had proved that the bow chains used in the clump and chain device not only interfered somewhat with the operation of anchor gear, but offered considerable resistance in the water. For this reason the bureau desired to develop, if possible, a design for a sliding bar shoe fitting for new battleships and battle cruisers under design. This fitting if adopted, would require a change in the design of the stem of these ships, and it was, therefore, decided that the British experience and developments along this line should be studied.

When this subject was taken up with the British paravane experts at Portsmouth Dockyard, England, it was found that they also were planning to discontinue the use of the clump and chain device on capital ships. They were, in fact, at the time designing a new type of sliding shoe to be tried out on H. M. S. *Hood*, their most recent capital ship.

Some slight changes and developments in the design of paravanes were found, but as the changes adopted were not radical they will not be described in this article. Also a complete history of the experience of the British Navy with paravanes was obtained at his time. The most interesting items in this history are as follows:

British History.—Paravanes were gradually developed during 1915 and 1916. At one time the Admiralty practically stopped the development work, believing paravanes could not be perfected in time to be of any value during the present war. The absolute confidence of Commander Burney, and one or two other British naval officers, in the value of the device, and their persistence with this idea, overcame the objections of the Admiralty and resulted in successful paravanes being manufactured in quantities early in 1917. By the summer of that year, practically all the battleships and cruisers of the British Fleet were equipped. At the same time, a contract was given to Vickers Limited to fit all

British merchant ships with paravanes as soon as possible. To accomplish this, Vickers formed an organization in each important port so that the vessels could be fitted as they became available. They also sent an organization to this country to equip British ships in American ports. Up to December 21, 1918, 2766 British merchant ships had been fitted with paravanes. The total estimated expense of the Admiralty in connection with protective paravanes was about nine and one-half million pounds sterling, of which three and one-half millions were expended on naval vessels, and six million on merchant ships. The number of mines cut by naval or merchant vessels reported up to December 21, 1918, was 72, subdivided as follows:

37 cut by light cruisers.
3 " " armed merchant cruisers.
1 " " a mine sweeper.
1 " " a cruiser.
1 " " a battle cruiser.
1 " " a battleship.
25 " " merchant ships.
3 " " a hospital ship.

In addition to these, 12 naval vessels and 12 merchant ships reported mines probably cut but as the evidence is not absolutely complete these are not included in the above list.

It is probably unnecessary to state that the British Admiralty considered the paravane of inestimable value. Naval critics have calculated that British ships to the value of $500,000,000 were saved by paravanes. In time of war, however, ships cannot be measured by money, as the time involved in the replacement of a lost ship is the serious factor.

Reward to Inventor.—It is understood that the inventor of this remarkable device will receive thirty thousand pounds sterling as a gratuitous award from the Admiralty for the use of his invention on naval vessels. He will also probably receive twice that amount from Vickers Limited in royalties on paravanes used on merchant ships. His services were also recognized by the Admiralty in promoting him from lieutenant to commander in the Royal Navy, and in conferring on him the Order of the Cross of St. Michael and St. George.

PROOF OF A SEVEN-INCH GUN AT MAXIMUM ANGLE OF ELEVATION, 40°, AT NEW LOWER STATION OF NAVAL PROVING GROUND.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

HOW THE NAVY DESIGNED AND BUILT THE WORLD'S HEAVIEST FIELD PIECE

THE BUREAU OF ORDNANCE BRINGS OUT AN ENTIRELY NOVEL TYPE OF MOUNT FOR A SEVEN-INCH NAVY GUN FOR THE U. S. MARINES

By Ensign C. L. McCrea, U. S. N. R. F.

Battleships of the *Connecticut* class when built were provided with a secondary battery of 7-inch 45-caliber guns mounted between decks. These seven-inch guns gave excellent service and were a good selection for the work that was expected of them, but had not been popular in the navy because they were too heavy for broadside work and too light for turret mounting, and a change was made in later battleships to the 5-inch 51-caliber guns, and then to 6-inch 53-caliber guns.

The experiences of torpedoed war vessels demonstrated the danger of having wide gun port openings in the broadside of vessels, such as the mounting of these 7-inch 45-caliber guns required in the *Connecticut* class. A heavy list from under water damage lowered the port sills to water, resulting in an inrush that capsized and sunk vessels that otherwise would have reached port. This being an undeniable fact, taught by bitter experience, the desirability of removing many of these guns and closing the ports when the battleships were assigned to convoy duty was self-evident. Therefore many of these guns were removed and thus became available for service elsewhere.

The seven-inch guns removed may be described about as follows:

The gun with breech mechanism weighs 28,700 pounds, or about 14 tons. It is 45 calibers, 315 inches, or about 26 feet long, and gives a 153-pound shell a muzzle velocity of 2800 feet per second. At a range of 14,000 yards the shell has a remaining velocity of 1250 feet per second, and can penetrate several inches of armor

Proof of a Seven-Inch Gun at Maximum Angle of Elevation, 40°, at New Lower Station of Naval Proving Ground.

plate. Its maximum range at an elevation of 40° is in the neighborhood of 24,000 yards.

On board ship, the mount for the gun weighed nearly 30,000 pounds, so that the total weight of the gun and mount was not far from 30 tons. When the gun recoiled after firing, the maximum trunnion pressure exerted was about 195,000 pounds. A hydraulic brake took up the recoil through a distance of 21 inches, and the gun was brought back to battery or firing position in the usual way by means of heavy helical springs contained in spring cylinders attached to the slide in which the gun operated. The mount was designed to allow a maximum elevation of the gun of 15°, which allowed a range of about 14,000 yards.

The guns were too heavy for anti-submarine work on merchant ships, patrol vessels, etc., but for land use they were an excellent weapon. The urgent need of our forces in France for artillery was, of course, known, and a means for placing these guns into action in the war was earnestly sought.

Early application for a number of these guns was made by the U. S. Army, and a number were turned over. The guns thus turned over were mounted by the army on railway cars. Special cars were used for this purpose, built with a drop frame bed so that the entire seven-inch gun and its mount, exactly as it was used on board ship, could be placed on it and yet clear the French tunnel roofs and bridges when in transit, but none of these guns so mounted were sent abroad for service during the war.

This railroad mount was limited in its use by the fact that the elevation limit set by conditions on board ship was still maintained; that is, the gun was still capable of a maximum elevation of but 15° with its corresponding range of 14,000 yards. Further, the heavy trunnion pressures existing on account of the short length of recoil of the gun, while entirely satisfactory on board ship where the structure of the vessel is built to stand them, were troublesome when the mount was placed on a railway car. Strong outriggers and bracing of the car and bed were required when the gun fired at targets at an angle to the line of the track on which the gun car was located.

When considering the best way to place these guns in the war, the Navy Bureau of Ordnance first gave attention to the plan of mounting them on railway cars. They first set to work to increase the permissible angle of elevation from 15° to 30°, feeling that this was the minimum that should be allowed. The designs

were soon completed. They called for the mounting of the guns on a special flat car, the bed of which was not dropped, but which had a heavy under-frame so that no bracing of the car, other than a few light outriggers, would be necessary when the gun fired. This called for the construction of a new mount in which the maximum elevation of 30° was possible, and in which the trunnion pressure was reduced to a value of about 65,000 pounds. In the new mount, the recoil was used to elevate the entire gun up an inclined runway in addition to overcoming the resistance of the hydraulic brake.

Word was received from abroad while these designs for a railway mount were being completed that better use of these seven-inch guns could be made if a suitable field mounting were developed for them, and, as they were navy guns, their operation would then be entrusted to the marines.

The allied armies required, and needed badly, a major caliber field piece of a range of 20,000 yards or so that was thoroughly mobile, and could travel over any country over which a tractor could go, and yet could be transported from place to place without disassembly. All of the large field guns in use by the British and French, as well as many of the smaller and less powerful howitzers, were so made that in order to transport them for even short distances the entire gun and mount had to be taken apart, the pieces loaded on separate trucks or carriages and transported as separate units, and then reassembled before fire could be recommenced. There was no such thing as a really mobile high-powered large caliber field piece that could be transported to the front on a moment's notice, and would arrive there ready to commence fire on the enemy without several hours hard work of preparation.

Rear Admiral Ralph Earle, chief of the Navy Bureau of Ordnance, recognized this need for a really mobile mount, and in a letter written to the Naval Gun Factory early in March, 1918, pointed out that the design and construction of such a mount for the navy seven-inch gun would mark a distinct advance and would fill a great need, and instructed them to start the work of design.

Work on the design of a mobile field mounting for the seven-inch gun was immediately started at the Naval Gun Factory, the date being March 15, 1918.

The Bureau of Ordnance was confronted with a problem which can be outlined about as follows:

A mobile mounting was desired for a seven-inch gun weighing 30,000 pounds—a mount that would allow the gun to be transported as a unit so that no preliminary preparation was necessary before firing. The seven-inch gun was the heaviest and hardest hitting gun for which a mobile field mount of this kind had ever been requested by any nation or army. The mounts were wanted in France before the close of the year 1918—a date less than nine months distant—so the time for design and construction was short.

With these conditions in mind, the gun designers of the Naval Gun Factory proceeded to study existing designs of field artillery that were available.

A brief examination of these designs showed that a wheeled mount for the seven-inch gun was not practicable. The weight of the gun and mount complete would be in the neighborhood of 70,000 pounds, or 35 tons. Assuming a six-foot wheel, and an arc of 25° in contact with the ground at any time, the total bearing surface to carry the load would be about six square feet, giving a ground pressure of about six tons per square foot, or 88 pounds per square inch. This weight was, of course, prohibitive, for the gun when moving over a road would probably leave its path marked by broken roadbed, and further, when the piece left the road and attempted to move over soft ground, there was every reason to believe that it would soon become hopelessly mired. Another doubtful point, also, was whether or not a wheeled mount of the ordinary type would prove satisfactory on firing, as wheeled mounts have a tendency to roll back on firing, and the weight of a large wheeled mount makes accurate aiming a different task.

A wheeled mount was clearly not practicable for the seven-inch gun, so a search was made for something better. At this point the idea of utilizing the principles of the so-called "caterpillar" belt for transporting the mount was suggested. Instead of wheels, it was proposed to use a steel frame with rollers carrying a link belt presenting a large flat surface to the ground. Similar material had been used with success on commercial tractors and on adaptations of them, etc., mounting small pieces of artillery, but never on a gun mount for a major caliber gun.

Yet there appeared no practical objection. Sufficient strength could be given to the construction of the tractor belt so that it would withstand the stresses brought to bear, and preliminary calculations showed a ground contact area of 28 square feet would be obtained giving a bearing pressure of about 18 pounds per square inch, which is about one-half of that exerted by a horse's hoof. Designs were accordingly commenced by the Naval Gun Factory on a mount of this type, to carry the seven-inch guns.

In order to save time in construction, it was hoped that it might be possible to incorporate into the caterpillar mount for the seven-inch gun a number of parts of the mount used on board ship, particularly the gun slide and the recoil and counter-recoil mechanism. It appeared more logical on considering the question, however, to lengthen the recoil of the gun as much as possible, thus reducing the trunnion pressure when firing and in turn the weight of the mount, than to build a heavy mount capable of standing the shock of firing with the short length of recoil set by conditions on board ship. Further, the counter-recoil mechanism of the marine mount was designed to return the gun to battery at elevations up to 15° only. An elevation of 40° was contemplated in the new land mount, making the design of a new counter-recoil mechanism necessary. It was soon found, therefore, that the designers must work from the ground up—every part of the mount had to be newly designed. Only the gun itself, with its breech mechanism and yoke, could be used of the material taken from the battleships.

Work on the designs was rushed at the Naval Gun Factory, and, in spite of the great pressure of other work, progressed rapidly. Preliminary designs were submitted within a fortnight: they called for a mount, the features of which were caterpillar belt wheels, a structural steel carriage, and a gun slide equipped with hydraulic recoil and pneumatic counter-recoil systems. These recoil systems allowed a recoil of 32 inches, which reduced the trunnion pressure from the value of 195,000 pounds in the original navy marine mount, to a value of 120,000 pounds.

Although entirely new, and at least a year ahead of the times, the designs were so carefully worked out and the engineering facts were so strikingly presented that immediate approval was given to the Navy Bureau of Ordnance by the chief of Naval Operations to proceed with the details and construction.

On May 25, the designs were pronounced complete, and, shown on 164 separate drawings, were ready for submission to the bidders.

DETAILED DESIGN OF THE SEVEN-INCH CATERPILLAR MOUNT

THE CATERPILLAR WHEELS

The construction of the caterpillar wheels can best be shown by the photograph.

In itself, the wheel consists of an endless belt of cast steel links, connected by hardened pins, each link carrying a corrugated forged steel plate which makes contact with the ground. The plates overlap when horizontal, so that a continuous surface is presented. Detachable grousers are provided to prevent the tread from slipping when the mount encounters soft ground.

The track links run over two large sprocket wheels and 11 truck and idler wheels as shown, the shafts on which these wheels turn being supported by a steel beam of special design. The sprocket wheels carry but little of the load except when the gun is descending a grade or when the brake is applied to the mount.

For smooth running and reliability, roller bearings are provided in the truck and idler rollers. The ends of the bearing housings are closed by steel plates to prevent the entrance of dirt, sand, etc., when the caterpillar is hauled through mud, sand, and soft earth.

A brake is provided to permit the control of the mount when descending hills, etc., and also to lock the caterpillar in position when the gun is set up for firing. The brake consists of a toggle joint operating on the rim of the sprocket wheel, the tension applied being controlled by an adjustable spring. This brake, although exceedingly simple, has been very satisfactory in operation in controlling the heavy mount on steep grades and in checking any tendency of the mount to move on firing.

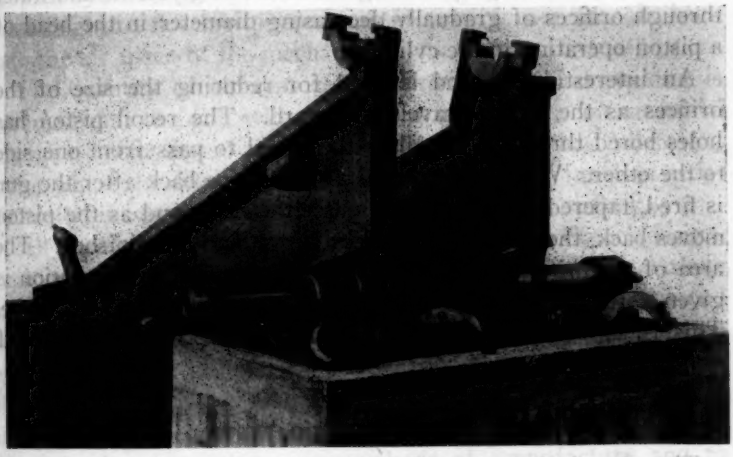
THE AXLE OF THE MOUNT AND THE METHOD OF ATTACHING THE CATERPILLAR WHEELS

The axle is a steel forging, nine inches in diameter with a five-inch central hole. It is supported in the wheel by a hub bracket, which in turn is carried by the structure of the girder on which the sprocket and truck wheels are mounted. This bracket is held by oscillating bearings and is spring supported so

that the caterpillar may adjust itself to any unevenness in the road when the gun is in motion. The springs are taken up by means of holding down screws when the gun is placed in firing position, in order that the mount may keep steady on the point of aim while firing.

THE GUN CARRIAGE

The carriage which supports the gun is a structural steel framework built up of standard steel shapes. It consists essentially of two main side girders cross-braced at each end to form a single unit with a central well into which the gun recoils.



CARRIAGE OF SEVEN-INCH MOUNT ON ASSEMBLING STAND SHOWING TRUNNIONS, AXLE AND A FEW OF THE COMPONENT PARTS.

To permit of accurate aim, a traversing gear is provided at the rear end of the gun carriage. A cast steel plate which rests on the ground is built into the structural work at the rear end of the trail and is held to the trail by clips. A worm shaft operated by ratchet wrenches shifts the trail with reference to the plate and enables the gun to be accurately trained.

The trunnion seats are located at the upper end of the carriage. A cylindrical casting, known as the gun slide, to which the trunnions are attached, carries the gun, according to standard navy practice.

The recoil and counter-recoil mechanisms are attached to the gun slide, operating through pistons attached to the yoke. When

recoiling, the gun runs in and out of the gun slide. Bronze liners are fitted to the inside of the slide to enable this to take place easily.

The trunnions of the gun are mounted sufficiently high so that at maximum angles of elevation only a shallow trench—about one foot in depth—need be dug to allow a clear space for the recoil of the gun.

THE RECOIL SYSTEM

The recoil system consists of a simple hydraulic brake. The energy of recoil is absorbed through a distance of 32 inches, as mentioned previously, by forcing a mixture of glycerine and water through orifices of gradually decreasing diameter in the head of a piston operating in the cylinder.

An interesting method is used for reducing the size of the orifices as the piston travels backward. The recoil piston has holes bored through it to allow the liquid to pass from one side to the other. When the piston starts to move back after the gun is fired, tapered throttling rods enter the holes and as the piston moves back, the size of the orifices is gradually diminished. The area of the orifices is so calculated that a constant retardation is given to the gun, and it is brought to rest at the end of the stroke. This is similar to the method used for checking the recoil of major caliber guns.

THE COUNTER-RECOIL SYSTEM

The seven-inch mount as installed aboard ship, it will be remembered, was capable of an elevation of but 15°, and springs were used to return the gun to firing position after recoil. With the new type of mount, however, spring return could not be made to function satisfactorily.

Pneumatic systems in use abroad were investigated in the search for a satisfactory counter-recoil mechanism for this heavy gun. It was decided after considerable study to use a counter-recoil mechanism of the French type, such as used on the 155 mm. guns, as it was felt that it would prove satisfactory.

In this type of mechanism, when the gun fires, a piston attached to the gun yoke moves backward in an airtight cylinder containing air at a pressure of several hundred pounds per square inch, still further compressing the air. When the gun has reached

the end of its travel in recoil the compressed air, acting upon the piston, brings the gun back into battery.

The only objections to the adoption of this system were the exceedingly close limits to which the manufacturers must work when machining, and the complications in the mechanism itself. This complication of parts was caused by the fact that a floating piston surrounded by liquid is used to prevent escape of high-pressure air. This piston is so arranged that should leakage of the confined air occur, it will serve merely to displace the liquid which surrounds the floating piston. When leakage has occurred to any considerable extent, it can easily be remedied by the use of a small hydraulic pump, which returns the liquid to the space surrounding the floating piston and in turn forces the air back into the air space of the mechanism.

The quantity of air that escapes from this liquid packing is so small that the gun will operate for a long time on an initial charge of compressed air, and when the pressure has fallen to a point where the counter-recoil mechanism will not function satisfactorily, it can easily be recharged by a pump or airflask.

All the parts were arranged in one cylinder in the French design, making the mechanism exceedingly compact. But this fact alone made machining and assembly operations difficult. Combined with the close limits set by the French, it was soon found that it was impossible to adopt the French designs. Accordingly, the designers of the Naval Gun Factory set to work to develop a new design of counter-recoil system, using the pneumatic principle, but adapting it to American methods of manufacture and to American shops.

The product of their work is shown in the photograph. The counter-recoil system, located on top of the gun, has been changed from a single cylinder to a combination of three cylinders, connected at the lower end by a cast bronze head. The piston attached to the yoke operates in the central cylinder. The system of liquid packing has been retained, but has been much simplified. The entire system is made up of shapes and material easily secured, does not call for extremely close machining, and is well adapted to American machining methods.

The elevating gear is a simple combination of a handwheel, worm gear, and rack and pinion that has been found to work out with extreme satisfaction in practice.

The sighting arrangements for the gun consist of a panoramic sight of standard design, fitted to a bracket attached to the gun carriage.

THE CONSTRUCTION OF THE SEVEN-INCH MOUNT

Preliminary designs for the seven-inch mounts were first undertaken on March 15, 1918. After consideration, as described in the preceding part of the article, detail designs were commenced, and on May 25, 1918, these were pronounced complete. One hundred and sixty-four separate drawings were required to show the material.

On May 30, 1918, proposals were sent out calling for bids for the manufacture of material. An initial construction of 20 of these mounts was decided upon. Proposals called for the delivery of the 20 mounts in 120 days.

Although many bids were received, the times of delivery set in most of them were far too long to warrant their consideration. The guns were needed in France, not in 1919 or 1920, but before the end of 1918. On June 18, 1918, therefore, the contract was awarded to the Baldwin Locomotive Works, Philadelphia, who agreed to undertake the manufacture and delivery of the 20 mounts in the time specified, in other words, by October 18, 1918.

Work moved rapidly forward from the first day. Material began to arrive at the Baldwin Works within a few days after the contract had been awarded and orders for material placed.

PERSONNEL TO OPERATE THE MOUNTS

While fabrication was going forward at the Baldwin Works, the marine corps organized a regiment of men to operate the guns. These men were placed in camp at Indian Head, Md. They were completely outfitted by the Bureau of Ordnance with motor trucks, supply and repair equipment, telephone equipment, etc., necessary for the operation of the batteries.

The first two mounts, complete and ready to fire, were shipped from the Baldwin Works on September 26, 1918, just 100 days from the date of the contract, and arrived at the Washington Navy Yard on September 30. They were sent to the Naval Proving Ground at Indian Head for road tests and proof firing.

Two three-ton trucks were found capable of hauling the mounts on arrival at Washington Navy Yard. The mounts, weighing

76,000 pounds each (38 tons) were hauled from the railroad tracks to the docks, where they were loaded on barges for shipment to the Proving Ground. One truck had sufficient power to drag the gun on level ground, but to negotiate an 8 per cent grade a second truck was necessary.

The marines were ready for the mounts when they arrived at Indian Head. The Bureau of Ordnance had provided, as part of the battery equipment, 120 h. p. gasoline tractors for hauling the guns. With the tractors hitched to the mounts, the guns were pulled up and down hill, over rough ground, and along hillsides. They proved themselves able to negotiate any ground over which the tractor itself was able to operate. Obstructions were mowed down, and yet the entire weight of the gun was so evenly and well distributed that no damage was done to roads when it was necessary to traverse them.

The guns were proof fired—and every expectation of the designers was fulfilled. The range of the gun, when firing at its maximum elevation of 40°, was 24,000 yards as predicted. The gun functioned perfectly, remaining steady on the point of aim even during continued firing. The caterpillar tread, locked in position by the brake, was as steady as a concrete foundation. The counter-recoil mechanism functioned perfectly.

Dispatch of men and material for France could have begun as early as October 15, and would then have been well toward completion on November 11. Due to a delay in fixing the port of debarkation, however, shipment was held up, and the armistice, of course, cut short the necessity for shipment. Had these seven-inch tractor mounts been placed in service, they would no doubt have given service equal to that given by the navy's 14-inch railway batteries.

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A FEW NOTES ON ALTERNATING CURRENTS

INCLUDING REMARKS ON INDUCTION MOTORS AND RADIO TELEGRAPHY

By LIEUT. COMMANDER LESLEY B. ANDERSON, U. S. Navy

There is no doubt that alternating currents have come in the navy to stay. At present they are applied to ship propulsion, radio, gyro-compasses, submarine signalling, navy yard light and power; and, on a smaller scale, to gun firing, three-wire generators, testing sets, magnetos, engine speed indicators, and electric welding. There is such a large field for development that the use of alternating currents will probably be greatly extended within the next few years.

The theory and application of alternating currents is a subject that is highly technical and most difficult. To master it requires several years of handling apparatus as well as book study. The

NOTE.—1. This paper is submitted for the use of the Institute if so desired.

2. The matter covered is elementary in character. It deals with alternating currents, their generation and application to induction motors and to radio.

3. There are a great many officers in the service who never had the benefit of any instruction in alternating currents while at the Naval Academy. For them there is a great deal of time and energy to be expended if they would understand anything about the subject. They are required to know something if they are to pass examinations, for alternating currents are becoming more and more important each day.

4. These notes fill in the space between the starting of the subject and the place where most papers, lectures and pamphlets on the various applications of alternating currents begin. In order to understand even a simple description of electric drive, an elementary knowledge of the subject is necessary.

5. There are no books that I know of that give the elementary conception of the subject in concrete form. They all seem to go into such detail that it is almost impossible for the beginner to get a general idea from them.

6. I believe that these notes give the general idea in a simple manner. They are mostly explanations that were given to midshipmen and reserve officers in conjunction with the study of the text. They were used in lectures and talks in the recitation room.

average naval officer is not interested to that extent. He is interested from a professional point of view more in what can be done, than in how it is done; and yet at the same time he is required to know something about how it is done.

The information regarding how it is done is not readily available. It is generally camouflaged in a mass of integral signs. But there are certain peculiarities of alternating currents that can be understood without introducing higher mathematics, and I believe that a general idea of the subject can be obtained without taking up a very great amount of time.

Alternating currents can be used for most of the things that direct currents can, and they are cheaper. They also can be used for some things that direct currents cannot. On the other hand, there are some things that alternating currents cannot do; for instance, only direct current can be used for charging storage batteries and, as will be shown later, for exciting the field of an alternator; so although A. C. is coming into greater use every day, it can never entirely replace direct current.

To start with, every one knows that an alternating current flows half the time in one direction and half the time in the opposite direction; and that reversals of direction are frequent. The question is, How can it be made to do work in one direction, so to speak, such as making a lamp burn steadily or turning over the *New Mexico's* propellers?

In the case of the lamp the explanation is easy. Electric current flowing in a wire will heat the wire. If the wire can be made hot enough it will give out light. Suppose the wire in question is the filament of a lamp. It does not make any difference to the filament whether the current is passed through it from starboard to port or from port to starboard. It is heated if current is passed through it. We can change the direction of the current as often as we please. It is the current that does the heating, and not the direction. It follows that alternating current can be used for the purpose of heating the filament just as well as direct current. Of course, the current must be supplied at proper voltage, and the frequency must be above 60 in order to prevent flickering. If these precautions are observed, the light is just as steady and effective as any that a direct current could produce.

Alternating currents require a circuit to run around on just as direct currents do. Voltage is necessary to produce any kind of current, but it must be an alternating voltage to produce an alternating current. This brings us to the first peculiarity of alternating currents, which is, that alternating voltages and currents do not of necessity act together; that is, they are not necessarily in phase. In some circuits the current is ahead of the voltage, while in others the voltage is ahead of the current. Alternating currents may "lead," "lag," or be "in phase," depending on the characteristics of the circuit. There are three factors which taken together impede the flow of alternating current: resistance, inductive reactance, and condensive reactance. While resistance tends to keep the current in phase with the voltage, both inductive and condensive reactance tend to throw it out of phase; their action is at right angles to the action of resistance. At the same time, they act opposite to each other. Inductive reactance tends to make the current lag; while condensive reactance tends to make it lead. There are several ways of proving these statements, but as the principal difficulty in studying alternating currents is the mastering of this and other proofs, let us for the present be satisfied with saying that it can be proved. It is the very foundation of the subject, consequently of the utmost importance. The amount that the current lags or leads is really a time interval, but it is not measured as such. For the purpose of measurement we consider that a cycle is made up of 360 electrical degrees, then we state the amount of phase difference as an angle, called the phase angle, and measured in degrees.

At this point it is necessary to introduce a few definitions. As an alternating current is continuously reversing its direction, it is convenient to consider one direction as positive, and the opposite as negative.

Cycle—One complete set of positive and negative values of an alternating current—360 electrical degrees.

Alternation—Half a cycle.

Period—The time required for the current to pass through one cycle.

Frequency—The number of cycles or periods per second.

High Frequency—Above 100,000 cycles per second.

Radio Frequency—From 20,000 to 1,000,000 or 2,000,000 cycles per second.

Audio Frequency—Below 20,000 cycles per second.

NOTE.—The frequency used for power transmission is about 25 cycles, for lighting about 60.

Inductance—Every conductor carrying current is surrounded by a magnetic field, which is brought into existence by the current. Any change in the magnitude of the current causes a corresponding change in the magnetic field. The field then, in changing, reacts on the conductor and induces in it an E. M. F. The induced E. M. F. opposes the change of current. When the current is increasing, the induced E. M. F. tends to keep it from doing so, therefore acts in a direction opposite to the current; when the current is decreasing in magnitude, the induced E. M. F. tends to keep it from doing so, therefore acts in the same direction as the current. Inductance, then, is the ability of a circuit to set up, of its own accord, a counter E. M. F. following changes in the circuit current.

Capacity—The charge of electricity that a conductor will hold. Capacity depends upon the shape and size and location with respect to other conductors. The most common form of capacity is the condenser, of which there are many types. The quantity of electricity that a condenser will hold depends upon the voltage, as well as the capacity. A tank of so many cubic feet capacity will hold that many cubic feet of air, but more air can be put into the tank by increasing the pressure; also, air can be taken out, thus reducing the pressure. It is the same thing with condensers; in that case voltage corresponds to pressure. There is thus a distinction between quantity and capacity.

In this paper certain symbols, which are generally accepted as standard, will be used:

A. C.—Alternating current.

D. C.—Direct current.

E. M. F. or simply E.—Voltage, or electromotive force.

I—Current.

R—Resistance.

L—Inductance.

C—Capacity.

X_L—Inductance reactance, which is equal numerically to $2\pi fL$.

X_c—Condensive reactance, which is equal numerically to $\frac{1}{2\pi fc}$.

X—Reactance, the algebraic sum of the condensive and inductive reactances.

Z—Impedance.

Θ—Phase angle, angle between the current and the voltage.

f—Frequency.

This is enough of the currents for the present. How they are generated is of more interest. After a short investigation of alternators we will be better prepared to understand the action of the currents a little better.

There are two conceptions of the generation of E. M. F., either of which can be used when it is the one best suited to the conditions. The first is, that an E. M. F. is generated in a conductor when it cuts lines of magnetic force; the second is, that an E. M. F. is generated in a coil or loop when there is a change in the number of lines of magnetic force threading through it. The first is the conception that is easiest to apply to generators, the second to transformers.

A generator consists essentially of an armature and a magnetic field. The field consists of magnetic lines of force. It is created by electromagnets called poles, which are designated North and South. The armature consists of the cutting conductors. The armature bars cut the lines of force and E. M. F.'s are induced in the bars. If the circuit is completed a current will flow. In connection with this conception relative motion of the cutting conductors and the lines of force is all that is required to generate an E. M. F., so it is immaterial whether the lines move or whether the conductors move.

Generator armatures generate alternating E. M. F.'s, which can be rectified by means of a commutator if direct current is required. If alternating current is required, the commutator is left off and collector rings used instead. The leads from the armature are then connected to the rings, and brushes take off the current as with direct current machines.

If rings are installed in addition to the commutator, and proper connections made, both alternating and direct current can be taken from the same armature at the same time. The direct current is taken off the commutator and the alternating current off the rings. Such machines are actually made and are called

double current generators. Three-wire generators have an alternating current end as well as a direct current end, both connected to the same armature.

There are three general types of alternating current generators or alternators: First, the revolving armature type; second, the revolving field type; third, the inductor type in which both the armature and field are stationary.

The revolving armature type does not differ greatly from a direct current machine. The field is excited by direct current taken from an independent source. This source is sometimes a D. C. generator on the main shaft or belt driven from the main shaft. It may be an entirely independent D. C. generator. It is usually called an "exciter." In place of the cummutator collector rings are placed on the shaft. From the collector rings brushes take off the alternating current. Only small machines are of this type.

The revolving field type is the most common type of alternator. The armature is wound on the stator, while the field windings or poles are secured to the shaft. The high voltage generated cannot be handled by brushes, so it is necessary to use the stationary armature. The armature windings and leads can be made as heavy and rugged as desired. As stated before, relative motion of conductors and magnetic lines of force is all that is required to generate E. M. F., so it is immaterial whether the lines move or the cutting conductors themselves. The field windings are excited by D. C. supplied by brush contact on slip rings. The D. C. voltage is low enough to be handled in this way.

The inductor type has both the armature and the field windings on the stator. The rotor is an iron drum which has projections equally spaced around it. There are as many projections as there are poles. When a projection is under a pole the reluctance of the magnetic circuit is not very great, but when it is midway between poles there is considerable reluctance. The result is a varying flux which induces an alternating current in the armature.

All the above types may be made single phase or polyphase.

Let us first consider the revolving field type. Fig. 1 gives an elementary conception of such a machine.

The moving part, or rotor, has counter-clockwise direction of rotation. Lines of force projecting radially from the poles sweep by the bars of the armature winding and are cut. As alternate

North and South poles follow each other by the armature bars, alternating voltages are generated in the armature. It must be remembered that alternators are not self-exciting like D. C. machines. The exciting current is direct current and comes from an outside source. The polarity of the field does not change, for

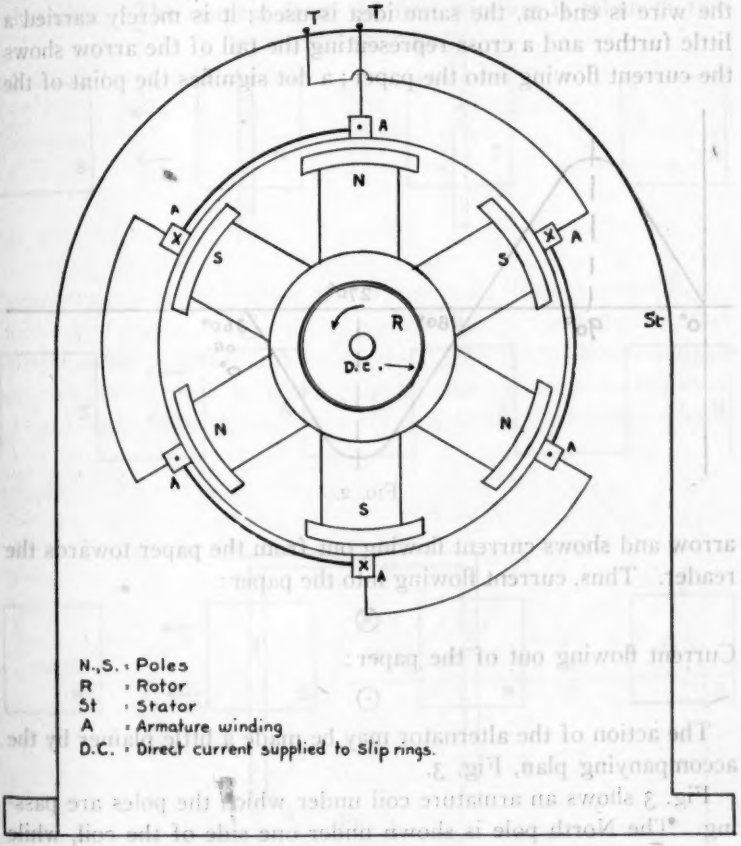


FIG. 1.

by using D. C. a North pole is always a North pole. It is only in the armature that the current is alternating.

The current generated is a periodic current. It may be represented graphically by the sine curve, which is also periodic. The different values of the current during the cycle are plotted as ordinates, while the horizontal axis is graduated in electrical de-

grees. One direction of the current is assumed as positive and plotted above the line. The other direction is then negative and plotted below the line, Fig. 2.

A conventional way of representing the direction in which a current is flowing is by using an arrow. When the wire is drawn lengthwise the head of the arrow points with the current. When the wire is end-on, the same idea is used; it is merely carried a little further and a cross representing the tail of the arrow shows the current flowing into the paper; a dot signifies the point of the

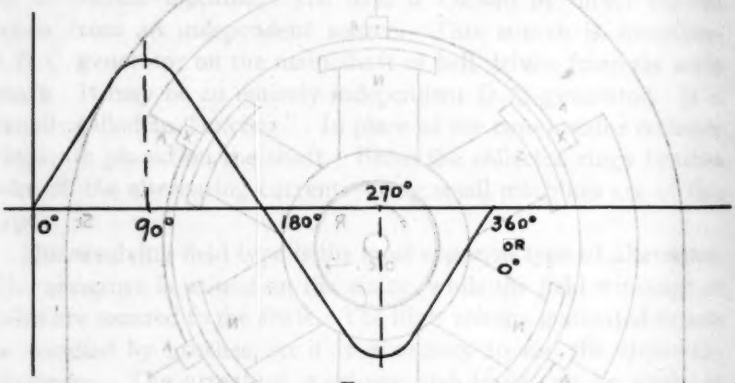


FIG. 2.

arrow and shows current flowing out from the paper towards the reader. Thus, current flowing into the paper:

⊗

Current flowing out of the paper:

⊙

The action of the alternator may be made a little plainer by the accompanying plan, Fig. 3.

Fig. 3 shows an armature coil under which the poles are passing. The North pole is shown under one side of the coil, while the South pole is under the other side. That armatures are actually wound with fractional pitch is not here considered. The two poles thus act together. The current generated flows in one direction around the coil. When the poles have moved 180 electrical degrees, the current in the coil is reversed, so an alternating current is generated in the coil. These conditions are

shown in the figure. This conception is that of a single phase or simple alternator.

It can be seen that a whole new armature winding can be added to the stator, independent of the first, with its cutting conductors placed half-way between the bars of the original winding. If so, we have the elementary conception of the two-phase alternator. The current from the first winding is taken to two

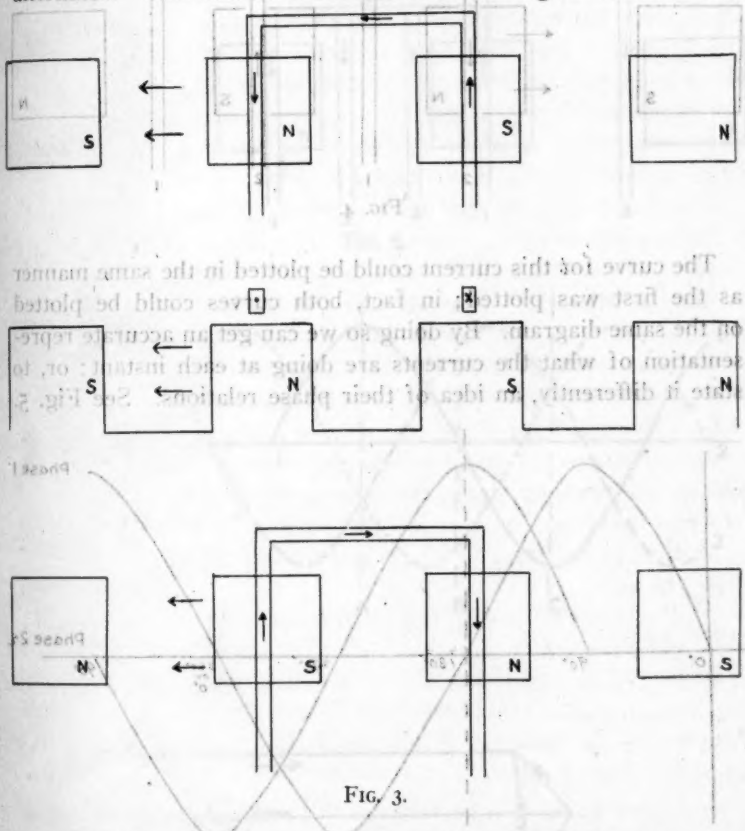


FIG. 3.

terminals, likewise the current from the second winding is taken to two terminals, making four terminals in all. Two distinct and separate currents are generated, which are similar in all respects, except that one is 90 electrical degrees behind the other in phase. The second winding, as stated, is 90 degrees from the first. Similar bars were placed half-way between the bars of the first winding. As one bar of the first winding is under a North pole

and the other under a South pole, the windings must be 180 degrees apart; half-way between them, then, is 90 degrees. See Fig. 4.

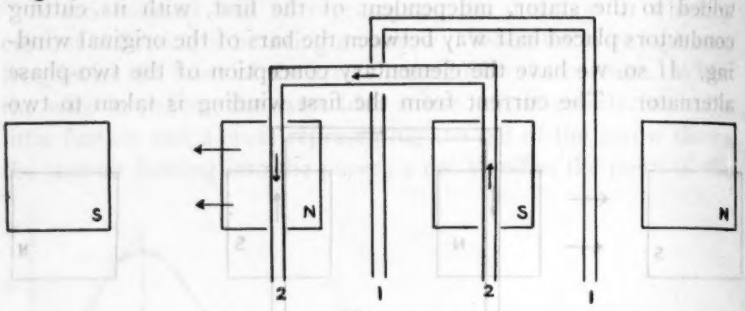


FIG. 4.

The curve for this current could be plotted in the same manner as the first was plotted; in fact, both curves could be plotted on the same diagram. By doing so we can get an accurate representation of what the currents are doing at each instant; or, to state it differently, an idea of their phase relations. See Fig. 5.

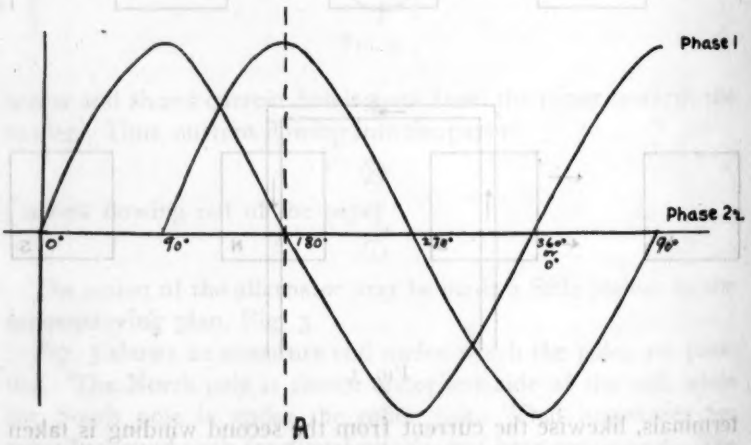


FIG. 5.

The winding of Fig. 4 is at the point *A* of Fig. 5; that is, the current in phase 1 is zero, while phase 2 is positive and maximum.

This same principle can be further extended to the elementary conception of the three-phase alternator. Instead of bisecting the

distance between the cutting bars of the first winding, suppose we trisect it. Also, instead of adding one new winding, suppose we add two windings. The leading edges of the coils are placed 120 electrical degrees apart in this case. The resulting

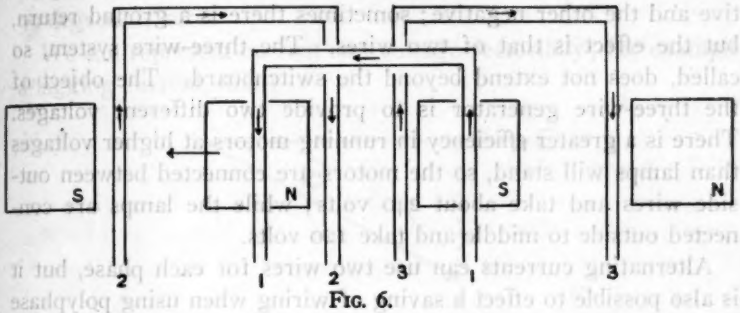
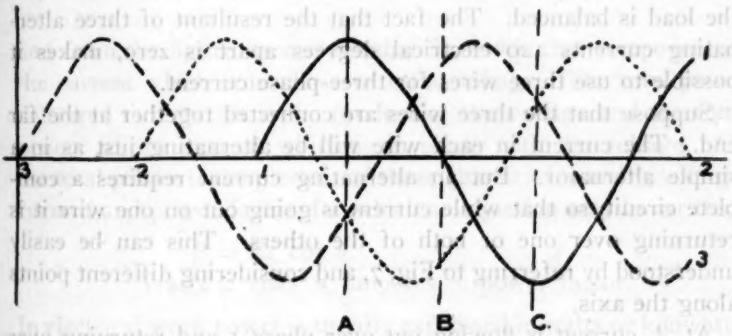


FIG. 6.



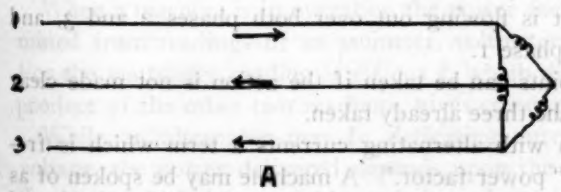


FIG. 7.—Line Wires Carrying the Currents Shown Above.

currents can then be plotted as three sine curves 120 degrees apart. See Figs. 6 and 7.

At the instant shown in Fig. 6, which is the point *A* of Fig. 7, current in phase 1 is positive and maximum; current in phase 2

is negative and increasing; current in phase 3 is negative and decreasing. At this point, as all others, the sum of the positive currents is equal to the sum of the negative.

Direct currents are ordinarily handled on two wires, one positive and the other negative; sometimes there is a ground return, but the effect is that of two wires. The three-wire system, so called, does not extend beyond the switchboard. The object of the three-wire generator is to provide two different voltages. There is a greater efficiency in running motors at higher voltages than lamps will stand, so the motors are connected between outside wires and take about 240 volts; while the lamps are connected outside to middle and take 120 volts.

Alternating currents can use two wires for each phase, but it is also possible to effect a saving of wiring when using polyphase current. Two-phase current can be handled on three wires, if the load is balanced. The fact that the resultant of three alternating currents 120 electrical degrees apart is zero, makes it possible to use three wires for three-phase current.

Suppose that the three wires are connected together at the far end. The current in each wire will be alternating just as in a simple alternator. But an alternating current requires a complete circuit, so that while current is going out on one wire it is returning over one or both of the others. This can be easily understood by referring to Fig. 7, and considering different points along the axis.

At *A*, current is flowing out over phase 1 and returning over 2 and 3.

At *B*, current is zero in phase 1. It is flowing out over phase 3 and returning over phase 2.

At *C*, current is flowing out over both phases 2 and 3, and returning over phase 1.

Any other points can be taken if the action is not made clear by considering the three already taken.

In connection with alternating currents a term which is frequently used is "power factor." A machine may be spoken of as having a high-power factor or low-power factor. High-power factor, of course, is the more desirable; and engineers, when designing, devote considerable time to methods of obtaining it. It has been shown that an alternating current is not always in phase with the voltage. The amount that the current lags or

leads is expressed as an angle. The natural cosine of this angle, which is called the phase angle, is the power factor. The more nearly the current is in phase with the voltage, the higher is the power factor; the cosine of zero degrees being one, while that of 90 degrees is zero.

We can represent current and voltage vectorially; for example, a lagging current, thus:

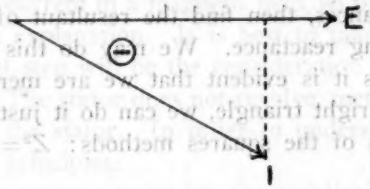


FIG. 8.

and from the figure we can see that $I \cos \theta$ is that component of the current which is in phase with the voltage. The total power delivered to a circuit is the product of the voltage and the component of the current which is in phase with the voltage. Or the total power is the product of three quantities, namely, voltage, current and power factor, for which an equation may be written:

$$P = EI \cos \theta.$$

Watts = volts × amperes × power factor.

In electrical work power is usually expressed in watts or kilowatts. If for any reason we want to change this unit to horsepower we can do so by observing the relation that one horsepower is equal to 746 watts. A kilowatt is 1000 watts.

When a machine is in operation the power factor can be determined from readings of an ammeter, voltmeter, and wattmeter. For the wattmeter reading is $EI \cos \theta$, which divided by EI, the product of the other two readings, gives $\cos \theta$, the power factor.

While an alternator may be delivering current at a certain voltage, the power delivered depends upon the power factor of the load, which is a variable and depends entirely on the load and not upon any characteristics of the alternator. Therefore, alternators are rated in volt amperes, or kilovolt amperes and not in watts or kilowatts.

The constants which impede the flow of alternating currents are three in number. They are all in the nature of a resistance and all are expressed in ohms. They consist of resistance, inductive reactance, and condensive reactance. As stated earlier, resistance tends to keep the current in phase with the voltage; inductive reactance to make it lag; and condensive reactance to make it lead. To find the impedance, which is the resultant of the three, we first take the difference between the inductive and condensive reactances, then find the resultant of the resistance and the remaining reactance. We may do this graphically, as in Fig. 8; or, as it is evident that we are merely finding the hypotenuse of a right triangle, we can do it just as well by the old familiar sum of the squares methods: $Z^2=R^2+X^2$, where $X^2=(X_L-X_C)^2$.

The last quantity of this equation is always positive, for the difference between the two numbers is squared, and the square is positive where the difference is positive or negative.

Ohm's law, which applies to direct currents, may be expressed as an equation: $I=\frac{E}{R}$, where I is the current in amperes, E the voltage in volts, and R the resistance in ohms. With alternating currents this equation takes the form: $I=\frac{E}{Z}$, where I is the current in amperes, E the voltage in volts, and Z the impedance in ohms. Knowing any two we can find the other one. This equation is the foundation of all A. C. calculations.

We can now turn our attention to the induction motor. It seems weird at first that a propeller shaft can be made to turn over at any desired speed when nothing is touching it, but anything that is weird is interesting.

We are familiar with generator action which is that relative motion of a conductor, and a magnetic field induces current in the conductor. Here we have mechanical power being supplied and producing electrical power. The motor is just the opposite, for electrical power is supplied and is converted by the motor into mechanical.

The action of a motor depends upon the fact that a conductor carrying current and in a magnetic field will tend to move. If the stator sets up the magnetic field, and the conductors carrying current are secured to the shaft, the shaft will revolve. The rotor

windings of most motors are supplied current by means of brush contact on a commutator or slip rings; but the rotor windings of an induction motor are not supplied current. The rotor currents are all induced currents. The stator is supplied current. It sets up a magnetic field. This field revolves, the conductors of the rotor cut the magnetic lines of force of the revolving field, inducing currents in the rotor windings. Then we have the conditions which must be fulfilled in a motor; namely, a conductor carrying current in a magnetic field, so the rotor revolves.

This requires explanation. It is best to take one thing at a time, so the first step will be the consideration of the revolving magnetic field. The stator does not revolve, merely the magnetic field set up by the stator. In order to understand it we must get back to first principles.

A conductor carrying current has surrounding it magnetic lines of force, or a magnetic flux. If the conductor is bent around in a circle or loop all the lines that were on one side of the wire will be sent through the loop. By increasing the number of turns of the loop, we increase the number of magnetic lines threading through it. Solenoids, or electromagnets, are made this way. The lines threading through the coil are the same as those of any magnet, so that one end of the coil is a North pole and the other end a South pole. If we reverse the current through the coil, we reverse the polarity of the magnet; what was North now becomes South, for the flux is now in the opposite direction.

The winding on the stator of an induction motor has the same effect as the coil, lines of force thread through it, so a magnetic field is set up. Consider the two-phase stator shown in Fig. 9 A. Phase 1 sets up a field with the North pole at one side when the current is flowing in one direction. When the current is reversed the side that was North becomes South. So phase 1 sets up an alternating magnetic field. The frequency of the field is the same as the frequency of the stator current, for every time the current is reversed the field is also reversed.

Phase 2 does the same as phase 1. Its windings are placed 90 degrees from phase 1, so its field is at right angles to the field of phase 1. The current in phase 2 is 90 degrees later than the current of phase 1.

That the result is a revolving magnetic field can be seen if we consider the action of the two-phase current in Fig. 9.

At the instant *A*, current in phase 1 is maximum and positive, while phase 2 has zero current. The direction of the resulting magnetic field is as shown at *A* in Fig. 9.

At the instant *C*, current in phase 2 is maximum and positive, while phase 1 has zero current. The resulting direction of the magnetic field is as shown at *C* in Fig. 9.

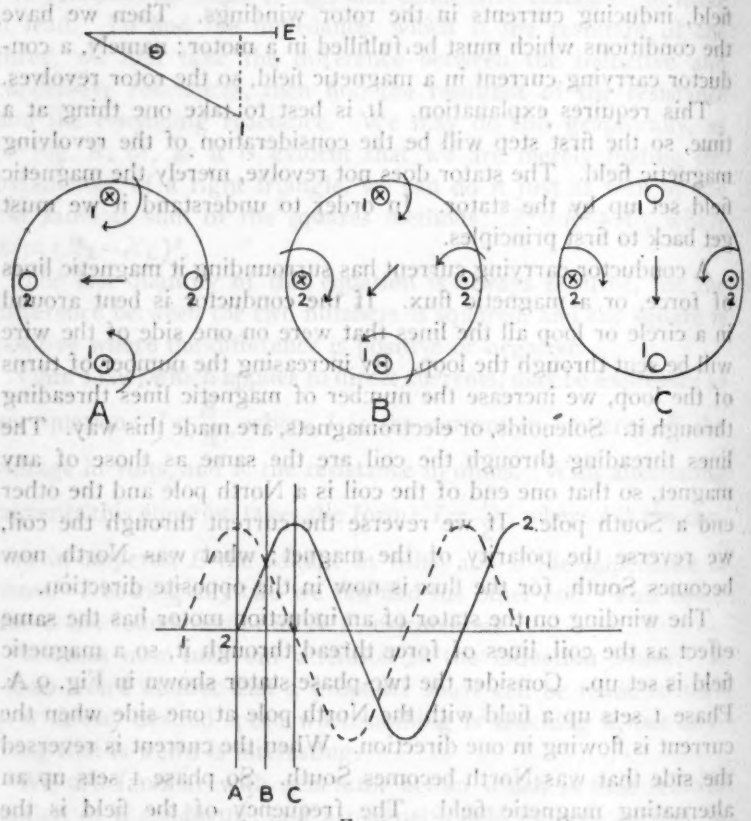


FIG. 9.

This shows that the field has changed direction 90 degrees, but to prove that it has actually revolved it is necessary to consider one or more intermediate points, such as *B*. At the instant *B*, current is flowing in both phase 1 and phase 2. The field set up will be the resultant of the fields of each phase, the direction of which is shown at *B* in Fig. 9.

We can follow the current through a complete cycle and will find that the magnetic field has actually made one complete revolution. The field revolves in synchronism with the current; that is, it goes through just as many electrical degrees as the current does.

Three-phase current has the same effect as two-phase. It sets up a revolving magnetic field which revolves at synchronous speed. Fig. 10 can be followed through in the same manner as was Fig. 9.

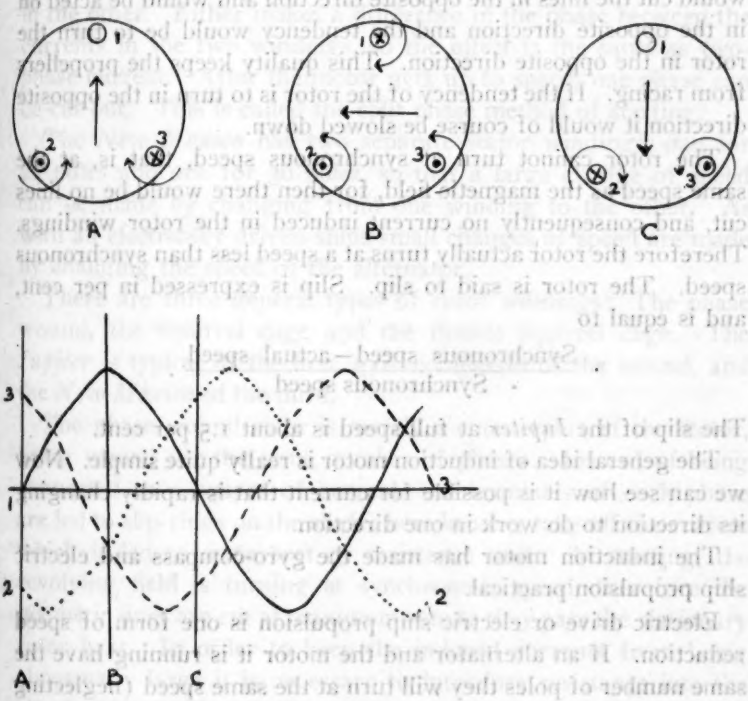


FIG. 10.

At point *A*, phase 1 is zero, phase 2 is negative, phase 3 is positive. The resulting direction of the field is shown at *A*.

At point *B*, phase 1 is positive, phases 2 and 3 are negative. The resulting field is shown at *B*.

At point *C*, phase 1 is zero, phase 2 is positive and phase 3 is negative. The resulting direction of the field is shown at *C*.

These three points have followed the current through 180 electrical degrees, and the field has revolved 180 electrical degrees.

At the instant of starting, the rotor, of course, is stationary. The bars of the rotor winding cut the lines of the revolving magnetic field, inducing current in the rotor windings. This is simply generator action. In addition we get motor action, for we have the condition of a conductor carrying current in a magnetic field. This is the principle of the induction motor.

The rotor cannot travel faster than the field, for if it did it would cut the lines in the opposite direction and would be acted on in the opposite direction and the tendency would be to turn the rotor in the opposite direction. This quality keeps the propellers from racing. If the tendency of the rotor is to turn in the opposite direction it would of course be slowed down.

The rotor cannot turn at synchronous speed, that is, at the same speed as the magnetic field, for then there would be no lines cut, and consequently no current induced in the rotor windings. Therefore the rotor actually turns at a speed less than synchronous speed. The rotor is said to slip. Slip is expressed in per cent, and is equal to

$$\frac{\text{Synchronous speed} - \text{actual speed}}{\text{Synchronous speed}}.$$

The slip of the *Jupiter* at full speed is about 1.5 per cent.

The general idea of induction motor is really quite simple. Now we can see how it is possible for current that is rapidly changing its direction to do work in one direction.

The induction motor has made the gyro-compass and electric ship propulsion practical.

Electric drive or electric ship propulsion is one form of speed reduction. If an alternator and the motor it is running have the same number of poles they will turn at the same speed (neglecting slip). If the motor has twice as many poles as the alternator it will revolve at half the alternator's speed.

In the case of the *Jupiter* the alternator is wound for two poles, the motors for 36, so that the speed reduction is about 18 to 1. The revolving field and the current go through the same number of electrical degrees; but while the alternator is so wound that it has 360 electrical degrees for 360 degrees of arc, the motor has 18×360, or 6480 electrical degrees for 360 degrees of arc.

A single phase induction motor is possible, although single phase current does not set up a revolving field. Once the rotor is up to speed the alternating field of single phase current will keep it going. The problem is how to start the motor. One method is to wind the stator as though two-phase current were to be used. In the leads to one phase put a condenser making the current lead the current in the other winding. Or in one lead put a large resistance making the current more nearly in phase with the voltage in that branch, and consequently ahead of the current in the other. Either makes a difference in the phase between the currents in the two windings, so the effect is the same as two-phase current. After the motor gets up to speed, one phase can be cut out. This is called the split phase method of starting.

The *New Mexico* has two separate stator windings, one for 24 poles and one for 36 poles, so that a large change of speed can be made by changing from one winding to the other. As with all electrically driven ships small changes of speed are made by changing the speed of the alternator.

There are three general types of rotor windings: The phase wound, the squirrel cage and the double squirrel cage. The *Jupiter* is typical of the first, gyro-compasses of the second, and the *New Mexico* of the third.

The phase wound rotor is merely a counterpart of the stator, being wound for the same number of phases. Instead of being connected to a source of current, the terminals of each phase are led to slip-rings on the shaft; here brushes take off the current which is led to some sort of resistance unit. At starting, the revolving field is turning at synchronous speed, therefore the magnetic lines are cut at maximum rate as they pass the stationary rotor bars. In order to keep the induced currents from being abnormally large it is necessary to introduce resistance into the circuit. When the rotor gets up to speed the rate at which the magnetic lines are cut is much smaller, therefore the induced current is much less. The resistance can then be cut out, or, as is usually done, short circuited.

The squirrel cage is much simpler. The winding consists of bars parallel to the shaft, around the rotor. A ring at each end touches all the conductors. Everything is thus short circuited, so the induced currents choose their own paths.

The double squirrel cage has two windings that parallel each other but are not connected. One is high resistance, the other is high reactance. Reactance depends upon the frequency of the current, for it increases with the rate of change of current. Therefore at starting the frequency being the greatest most of the current will be sent through the high resistance winding. As the rotor gets up to speed and the frequency becomes less, more current is sent through the low resistance winding. In this type of rotor, then, the insertion of starting resistance is automatic.

There is no provision for inserting starting resistance in the squirrel cage rotor.

In large motors there is considerable heat developed in the resistance which is used at starting. The heat thus developed is dissipated by using water cooled resistance units, or water rheostats, and by circulating air through the machine. The designer in addition to providing means of carrying off the heat developed has a big insulation problem to contend with. The winding in all rotors is of course insulated from the rotor body or frame.

There is one other feature of induction motors that should be mentioned before leaving the subject, that is the matter of reversal of direction of rotation. The two-phase rotor is reversed by reversing one phase, the three-phase by interchanging two of the phases. That this is so can be seen in Figs. 9 and 10 which show elementary stator windings. If the direction of rotation of the revolving magnetic field is accomplished the reversal of the rotor follows.

Radio depends upon the fact that electromagnetic waves can be sent through space. Having established that fact various methods of signaling by means of these waves were developed. Signals can be made by interrupting the waves or by varying them in some way.

The velocity of the waves is 300,000,000 meters per second. It cannot be changed, but the length of the waves can be changed by varying the frequency. The frequency, in turn, depends upon the capacity and inductance of the radiating circuit. So it is only necessary to vary one or the other of these constants, L or C, in order to vary the wave length.

The mathematics involved is very easy to follow and shows the relations so well that it will be introduced here.

Let V stand for velocity, λ for wave length, f for frequency, and, as previously given, R resistance, L inductance, C capacity, X reactance, X_L inductive reactance, X_C condensive reactance. Then:

$$(1)\quad \lambda = \frac{V}{f}.$$

$$I = \frac{E}{Z}.$$

$$Z = \sqrt{R^2 + X^2}.$$

$$X^2 = (X_L - X_C)^2.$$

$$X_L = 2\pi fL.$$

$$X_C = \frac{1}{2\pi fC}.$$

$$\therefore I = \frac{E}{\sqrt{R^2 + \left(2\pi fL - \frac{1}{2\pi fC}\right)^2}}.$$

which of course is maximum when the second expression under the radical is equal to zero, or when $2\pi fL = \frac{1}{2\pi fC}$. This condition of the circuit is called resonance. Two circuits are said to be in resonance when they have the same wave length.

The frequency at which this maximum current occurs is called the critical frequency; it can be found from the last expression to be

$$f = \frac{1}{2\pi\sqrt{LC}}.$$

Substitute in equation (1)

$$\lambda = \frac{V}{f} = V 2\pi\sqrt{LC},$$

which can be further simplified to $\lambda = 1884\sqrt{LC}$, where L is microhenries and C is microfarads. This is important because "tuning" is merely changing the wave length, and this shows that it is accomplished by varying either capacity or inductance, or both.

Varying the wave length by changing the inductance is one of the methods that is used in sending signals. A continuous wave is sent out. When the key is pressed it changes the inductance of the circuit, therefore the wave length. The receiving station

is tuned to receive only that wave length which is radiated when the key is pressed.

With this in mind the elementary idea of the "arc sets," such as are used at high-power stations can be easily understood. Fig. 11 gives the elementary layout.

Even before radio existed it was known that an arc produced by D. C. would set up electric oscillations, if in circuit with an inductance and a condenser; and that these oscillations were

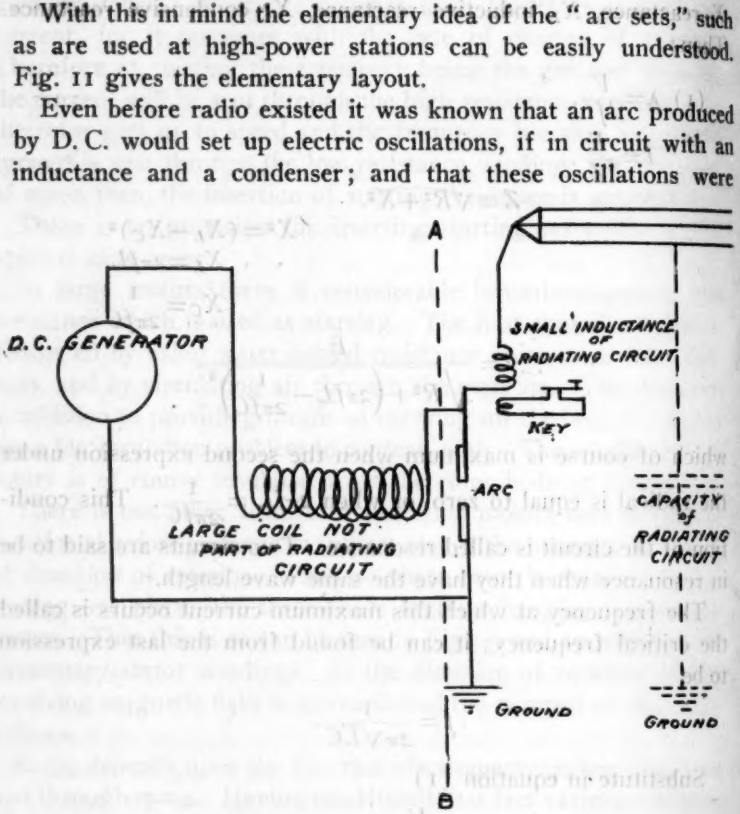


FIG. 11.

produced continuously if the circuit was properly adjusted. It can be seen from the figure that the arc has an inductance in circuit with it. The aerial and the ground or ballast with air between form the condenser, which is shown dotted in the figure. The circuit is completed through the two grounds.

The large inductance serves two purposes. It prevents rush of current back over the line, and it blows out the arc. It has nothing to do with the *LC* of the set. It is not a part of the radiating circuit. The current that passes through it is unidirectional. The radiating circuit is everything to the right of the dotted line *AB*. It is a complete circuit in itself, as stated above.

The key in small sets is so connected that when it is closed it short circuits part of the small inductance of the radiating circuit, thus changing the inductance. In large sets it is inductively coupled, as shown in Fig. 11. Due to transformer action current is set up in the key circuit when the key is closed. This current creates its own field, which in turn reacts on the already existing field of the coil in the radiating circuit, changing the inductance of this circuit, due to the change of magnetic flux. Consequently, the wave length is changed. This interaction of two coils on each other is called "mutual inductance" to distinguish from self-inductance already described.

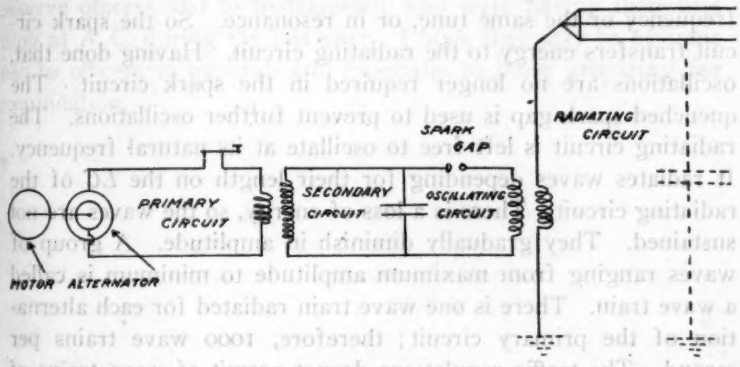


FIG. 12.

The key can be operated locally, or if connected through proper relay, messages can be sent from a distance. For instance, an operator in Washington can send signals out over the station at Annapolis.

A second method of making signals with these electromagnetic waves is to have a key which completes the circuit. Then waves are only sent out when the key is pressed. The system is used with spark sets.

"Spark sets" require A. C. in the primary circuit. The inductor type of alternator is used to supply the current. The frequency is 500 cycles per second. This frequency is only in the primary and secondary circuits. The radiating circuit depends on its own L_C for its frequency, just as in the previous set. Fig. 12 shows the elementary layout.

The frequency of the primary and secondary circuits is 500, so that when the key is pressed the condenser is charged 1000 times per second; once for each alternation. But this frequency is much lower than the oscillations set up by the condenser, after being charged. These oscillations are set up in the spark or oscillating circuit. The frequency of this circuit depends upon its inductance and capacity. Only once during each alternation is the condenser charged to high enough potential to break down the spark gap, but having broken it down it sets up high frequency oscillations in that circuit. The *LC* of the spark circuit is the same as the *LC* of the radiating circuit; that is, the two circuits are of the same frequency or the same tune, or in resonance. So the spark circuit transfers energy to the radiating circuit. Having done that, oscillations are no longer required in the spark circuit. The quenched spark gap is used to prevent further oscillations. The radiating circuit is left free to oscillate at its natural frequency. It radiates waves depending for their length on the *LC* of the radiating circuit. There is a loss of energy, so the waves are not sustained. They gradually diminish in amplitude. A group of waves ranging from maximum amplitude to minimum is called a wave train. There is one wave train radiated for each alternation of the primary circuit; therefore, 1000 wave trains per second. The traffic regulations do not permit of wave trains of less than 15 waves per train, which corresponds to a log decrement of two-tenths.

If the propagation of waves is understood, the methods of receiving them and distinguishing dots and dashes naturally follow. All tones depend upon the frequency of vibration or the frequency of the wave. Low tones are of low frequency, and higher frequencies produce a higher tone or pitch. When the frequency is above 20,000 the tones are inaudible, but the vibrations are there just the same. Radio receiving consists of changing the high frequency of the incoming waves to a frequency that can be heard. Undamped or continuous waves can be made audible by setting up local vibrations in the receiving circuit at slightly different frequency; resulting in the production of beats at audio frequency. The frequency of the beats is the difference between that of the incoming waves and the local waves. This is the heterodyne principle.

Damped waves are readily heard because each wave train as it comes in gives one impulse. The current is rectified and one click of the telephone diaphragm results. The frequency of the wave trains is one within the range of audibility.

For amplifying, rectifying, and production of beats by setting up local oscillations, the vacuum tube, which is also called by various names, such as audion, ultra-audion, audodyne, etc., is used. There is no short cut to familiarity with the vacuum tube. There are several books on the subject for those who are interested.

The above notes are extracts from talks and lectures given to reserve officers and to midshipmen who were having their first fling at A. C. during the last year. I hope they may be of some use to officers in general, and especially to those preparing for examination.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

GREAT CIRCLE SAILING—A FEW "WRINKLES" TO SAVE TIME

By COMMANDER H. G. S. WALLACE, U. S. Navy

Now that so many ships are making trips across the Atlantic, a few notes on great circle sailing may be of timely interest.

There are in common use two methods of getting the great circle distance between two points. These are: (1) By measurement from the great circle chart; (2) by computation from formulæ derived from Napier's rules.

The first of these methods, measurement from the great circle chart, requires (usually) a rather long preliminary study of the method (or methods, as two are given in the printed instructions on the chart) before one is sufficiently familiar to start on the case in hand. In addition to the inconvenience and delay, the result attained is only approximate, and has a probable error in the neighborhood of 10 to 20 miles.

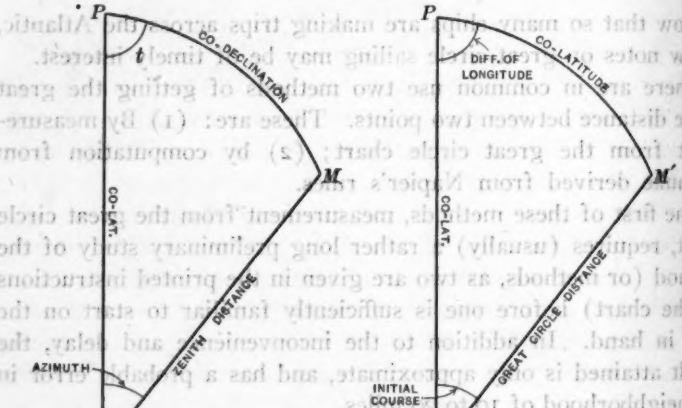
The second method, computation from Napier's rules, requires the navigator to burden his memory with a rarely used formula, or else to look it up in Bowditch or elsewhere before using; and after getting it, he must be familiar with the signs of the various functions in the various quadrants, and carefully observe them, or the result will be liable to error.

It requires no argument to prove that any method which involves little-used formulæ, or which requires a preliminary study, or which fails to give a reasonably correct answer, is faulty in actual service. The chances of mistakes are already too many, and anything which adds unnecessarily to these should be avoided.

Happily there is an easier method, one which is available to the average navigator without any preliminary study, and which gives results that are not only accurate, but quickly attained. It is nothing else than our old friend, the Marcq Saint-Hilaire.

The analogy between the astronomical triangle and the terrestrial triangle is very close.

By comparing the two triangles in the figure, it appears at once how the Marcq Saint-Hilaire method is applicable, as it is simply necessary to substitute (1) the latitude of the destination in place of the declination of the heavenly body, and (2) the difference of longitude in place of the hour-angle. It is not even necessary to reduce the difference of longitude to time, as the haversine tables in Bowditch give the functions for one as readily as for the other. The zenith distance, reduced to minutes of arc, is the desired great circle distance between the two points.



ASTRONOMICAL TRIANGLE. TERRESTRIAL TRIANGLE.

P = Pole. P = Pole.
Z = Zenith. Z = Zenith.
M = Heavenly body. M' = Destination

Example.—Find the great circle distance between Lat. 45° 40′ N. Long. 2° 50′ W., and Lat. 41° 00′ N. Long. 50° 00′ W.

L_1	45°	40′ N.	λ_1	2°	50′ W.
L_2	41	00 N.	λ_2	50	00 W.
$L_1 \sim L_2$	4°	40′	$\triangle\lambda$	47	10
$\triangle\lambda$	47°	10′ log hav 9.20430			
L^1	45	40 log cos 9.84437			
L_2	41	00 log cos 9.87778			
		log hav 8.92645			N. hav .08443
$L_1 \sim L_2$	4°	40′			N. hav .00166

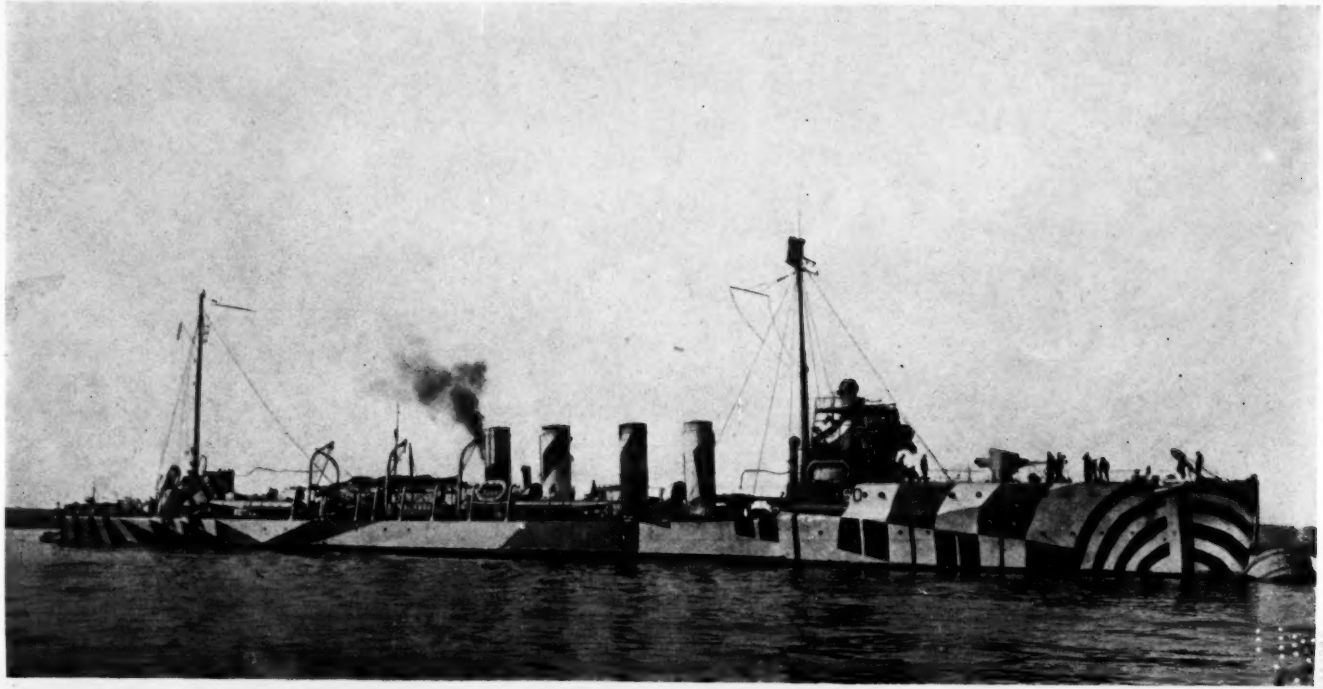
Zenith distance 34° 07.5′ ..... N. hav .08609
Great circle distance 2047.5 miles.

The initial course is readily obtained by solving the same triangle to get the azimuth, using any of the well-known methods. In this case the difference of longitude must be reduced to time, as azimuth tables and diagrams do not have the hour-angle expressed in arc.

The easiest method of actually following a great circle is usually by drawing a straight line between the two points on a great circle chart, picking off points on the line every 5° or 10° apart, and plotting these points on a Mercator's chart, then connecting by a fair curve. If this method is followed, the course at any point may be taken directly from the chart by means of the parallel rulers. This is easier than computing the successive courses, and is equally satisfactory in practice.

The writer accidentally hit on the above method for computing the great circle distance, and wondered whether so easy and obvious a method could have escaped observation. It is not given in Bowditch, but it has since developed that the late edition of Muir (1918) contains the formula on p. 267, and an example is given on p. 270. It is, however, not pointed out that the formula is the same as that of the ordinary Marcq Saint-Hilaire sight, and the close analogy between the two might readily escape observation, even from a person making a fairly careful study of Muir.

It is believed that in any case the method will prove of interest to those who, not having a copy of Muir, have not seen it, or, having seen it, have not happened to notice the analogy.



U. S. S. "WADSWORTH."

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NOTES ON HANDLING DESTROYERS

By COMMANDER C. C. SLAYTON, U. S. Navy

INTRODUCTION

The writer has been hoping for a long time that some of the many really expert destroyer commanders would write about some of the results of their experiences and observations of handling destroyers.

Finally in sheer desperation, perhaps with the idea of "starting something," some observations of three rather busy years handling and watching others handle them under many and varied conditions have been jotted down. These notes are not intended as a treatise on "How to Handle Destroyers"; they are simply a few observations concerning some of the mistakes often made.

It must be remembered that no two vessels handle alike; also, that no two men will handle their ships exactly the same. No fixed rules can be laid down, and it is not the writer's desire to have these remarks considered as such. After all, experience is the best teacher, but it is hoped that these notes may be of value to the new men coming to command destroyers.

The handling of a destroyer alongside a dock or alongside other other vessels is to most destroyer men a never-failing source of fascination. A destroyer is a light vessel, very much affected by the wind, which has an effect on the high bow like that on the jib of a sailing vessel; a vessel of high power; swift; quick to answer the rudder; with fairly small turning circle; and withal so delicate that a little misjudgment may quite easily result in torn plates, a mowing down of your own or another's stanchions, bent gun training gears, damaged torpedo-tubes, damaged propeller guard, or propeller.

And never are the conditions exactly the same! How many times the young skipper, exasperated by what he thinks is a landing not 100 per cent seamanlike, exclaims, "Now why in the name of all that's holy didn't the darned stern swing in as it

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usually does!" It is so easy to overlook one of the many little points, as wind, eddy currents, etc., a forgetfulness that may mean overtime work for the repair gang.

When many destroyers are based on a port, it becomes necessary for a great deal of this kind of ship handling, and experience has shown that under such conditions there will be a good many cases of minor damage. Our destroyer repair ships overseas will testify that the hull and upper deck fittings are frail structures, judging from the way they had to work to keep the destroyer on the job.

DIFFERENT DESTROYER TYPES

Before proceeding with an account of the mistakes commonly made, it would be well to examine some of the points wherein the several types of destroyers differ, in regard to maneuvering qualities.

The vessels before the 700-ton class are not considered in this article.

1. *Triple Screw 700- and 750-Ton.*—These have small fast moving screws, small turning leverage and small backing power.

In order to turn in a short space it is best to use the rudder and get way on, shifting rudder *when dead in the water.* The kick of the "inboard screw" backing as it churns when started is of great assistance.

The wind effect on the high bow of these destroyers is most marked, especially when backing.

The twin-screw boats have better turning leverage, but have the disadvantage of less backing power than later boats.

2. *Thousand-Ton Destroyers* with larger and slow moving screw, greater turning leverage and greater backing power, can ordinarily be turned in a very small circle, using one screw ahead and the other backing. They turn best with a little ahead motion of the ship. The wind has less "jib effect" on these on account of the high boat skids aft.

3. *Twelve-Hundred-Ton Destroyers* having more power are still easier to handle, but care must be taken to use this power judiciously, in order not to start ahead or astern with a rush. It has also been noted that one must anticipate a little, for a signal from the bridge does not result in a reversal or starting of the engine as quickly as in the smaller ones, and when they do start, as one captain said, "You know it." This slowness of starting may apply to only a few of the boats, for another captain says

that you get the effect of a reversal or change of engines very quickly.

The destroyers of the latest design should be particularly easy to handle, on account of their cut-away stern. This makes them very sensitive to rudder changes. Their deeper draft when loaded will make them less susceptible to the wind, which is a bugbear to most destroyer men, when it cannot be used to help. It may be remarked that the officer of the deck and steersman will have to be very much on the job when running before a quartering sea, due to excessive yawing, especially in shallow water.

REASONS FOR MISTAKES

1. Insufficient knowledge of the maneuvering qualities of the ship; how wind and tide effect its handling, and how to make allowances therefor.
2. Use of excessive speed.
3. Use of too little power.
4. Lack of confidence; indecision.
5. Insufficient or improper use of lines.

The remarks in this article are chiefly applicable to vessels of the " 1000-ton " type, except where a certain type is specifically mentioned.

INSUFFICIENT KNOWLEDGE

The knowledge of how ships will act under varying conditions is one which cannot altogether be learned from books, tactical data, or the thorough analysis of the effect of the rudder and screw in Knight; these should all be studied, but before one can become an expert at handling his ship a certain amount of experience must be had to round out his knowledge.

The quickest way to turn, in point of time, is at a fair speed, both engines ahead, and with full rudder. The slowest is with practically no way at all, one engine ahead, the other astern.

Therefore, desiring to get around in the shortest time, you should turn with as much headway as possible, consistent with safety. Ordinarily, to turn in a limited space with boats of the 1000-ton class, it will be found best to so regulate the speed that the effect of the engine going ahead is a little greater than that of the engine going astern. And, moreover, the more power (*not speed*) the quicker the turn.

But with the lighter 700- and 750-ton boats, especially those with the Parsons' installation, it will be found that it is almost

impossible to turn in a limited space without surging back and forth, and the continuous backing of one screw while the other is going ahead is hardly worth while, unless wind conditions are such as to help push the bow around. With these boats, the effect

WHAT THE "FISH BOAT" DID TO ME.

of the rudder is greater than screw current or sidewise pressure of the screw, as long as the ship has way; so that it is best not to shift the rudder, when the inboard screw is reversed, until the ship has lost all headway. An exception may be noted here that when the inboard screw first goes astern, an appreciable kick of the stern is felt which decreases as the headway is diminished. So it often may be found convenient to keep one engine going

ahead, and to start and to stop the inboard engine (going astern) from time to time. When the outboard engine starts ahead, the screw current acting on the rudder tends to diminish the turning effect of the rudder, due to ship moving ahead, and you must be prompt to shift the rudder.

A big factor with these boats is the lack of power. If you have only two boilers lighted, especially when you are just getting under way, any continued work with one engine backing and the other going ahead will soon kill your pressure, and you may find yourself adrift, not under control.

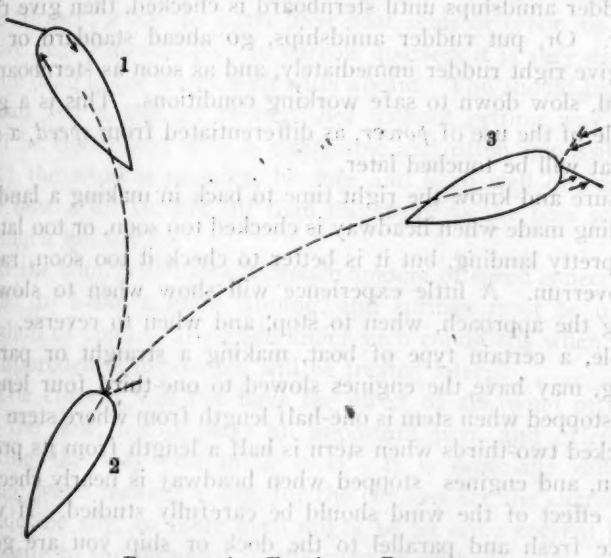

DIAGRAM A.—Turning a Destroyer.

Position 1: Port screw ahead; starboard backing; rudder full left.
Position 2: Starboard screw backing; port stopped. Shift rudder when dead in water.
Position 3: Screws as in Position 1. Arrows show forces acting against turning.

If it is necessary, due to vessels, buoys, etc., to gain distance astern while turning in a limited space (handling a "1000-tonner" or greater) the following point must be remembered: The rudder should be shifted *when headway is lost;* but, when going ahead after backing, the rudder should be shifted (or better yet brought amidships) *when the "outboard screw" is started ahead.*

In Diagram "A" a destroyer at (1), with right rudder, port screw ahead, starboard backing, turns quite well. Then port

engine is stopped, speed of starboard engine (backing) is increased. When dead in the water, rudder is shifted. Ship will turn, but not as much as when going ahead, because the effect of screw current is not so great. Now in position (3), if port engine is started ahead, it will be found that the screw current acting against the left rudder will tend to throw the stern to starboard, nullifying what you want to do. On the other hand, if the rudder is immediately *shifted,* the pressure of the water due to the ship's sternboard will also tend to throw the stern to starboard.

Therefore, in this case, it will probably be found best to put the rudder amidships until sternboard is checked, then give right rudder. Or, put rudder amidships, go ahead standard or full *both,* give right rudder immediately, and as soon as sternboard is checked, slow down to safe working conditions. This is a good example of the use of *power,* as differentiated from *speed,* a subject that will be touched later.

Be sure and know the right time to back in making a landing. A landing made when headway is checked too soon, or too late, is not a pretty landing, but it is better to check it too soon, rather than overrun. A little experience will show when to slow, in making the approach, when to stop, and when to reverse. For example, a certain type of boat, making a straight or parallel landing, may have the engines slowed to one-third four lengths away, stopped when stem is one-half length from where stern is to be, backed two-thirds when stern is half a length from its proper position, and engines stopped when headway is nearly checked.

The effect of the wind should be carefully studied. If wind is quite fresh and parallel to the dock or ship you are going alongside of, be sure you do not get your bow canted either way. If bow is canted outward, it will be nearly impossible to make a good landing. If is canted towards the dock or ship you run serious risk of doing damage. This is the most frequent cause of damage to other destroyers and your own. For the wind blows the bow in more and more, and if headway is still carried, the anchor or bill board will make a clean sweep of your neighbor's stanchions. In some cases, if you back hard enough, the stern may go in and the bow out, due to pivoting, but more likely the bow will come in, you will gather sternboard, and your neighbor will be raked worse than ever. And you may leave your anchor on her whaleboat davits. Best thing to do is not to at-

tempt to get out clear. Use the engines to stop headway, get out some lines *quickly;* hold her there and let her swing parallel. This will localize the damage, at any rate. Then you can tell your brother captain you will send your blacksmith and carpenter over to repair the damage. This last is an important bit of etiquette that should not be forgotten by young destroyer skippers!

The effect of the wind is strongest when the ship is backed, and is most marked in the 700- and 750-ton classes. They will back dead into the wind. The bigger boats tend to seek a heading with wind on the quarter. This is due to the high forecastle of the former; while the latter have boat skids or other top hamper more nearly amidships. In narrow quarters it is very dangerous to lie dead in the water with wind abeam. You should have room ahead, for if you try to twist her without getting way on, you will be confronted with a wearisome and often impossible task.

If the wind is onshore, be sure and keep well off, and keep the bow a bit further off than the stern, as the bow will come in much quicker.

If the wind is offshore, a certain amount of speed is necessary in order to make a good landing, and springs must be used. A method of coming alongside under such conditions when a parallel approach is impossible will be treated later.

The current will not have the effect of the wind in blowing off the bow, but it plays an important part, and often is not setting the way you think it is. It is especially difficult to judge when making a slip, for the chances are the current is *nil* inside the slip, or there even might be an eddy current inshore, opposite to the direction of the current offshore. The coal slips at the navy yard, New York, the slips at the torpedo station at Newport, and the old dock at Pensacola, are examples of where eddy currents may be encountered. Careful judgment and experience are necessary.

The question of what the ship will do with one or both screws astern is not well understood by many captains, and a better knowledge will not only avoid damage by knowing when not to back, but also knowing how to back may give one the opportunity to make some very pretty landings.

Always leave the dock or ship by going ahead if possible. The ship is under much better control when going ahead, and the engines are better able to give you what you want. If you back

away, the bow may pay off toward the dock or the vessel alongside, for, as has been remarked, the ship is more at the mercy of the wind, etc., when backing than when going ahead. Furthermore, the initial "kick" of the engines going astern may not be equal, causing the ship to cant one way or the other.

The "kick" comprises two elements: (1) The sidewise pressure of the blades deepest immersed (very noticeable when the screw churns on first starting); and (2) the pressure of the screw current on the hull. The first has the strongest effect and it diminishes when the ship gathers sternboard.

In going ahead you should not give much rudder to swing the bow out, for the stern will come in fast, and your propeller guard may leave a long mark on your neighbor. In some cases it will even be necessary to shift the rudder, to swing the stern out, in order to avoid fouling the anchor chain or buoy of your neighbor. If there is a slight tendency of wind or current setting you down on your neighbor, often a good bit of speed is necessary.

If conditions are better for backing, it is best to get away quickly in most cases, in order to obtain some steering effect of the rudder and to minimize the effect of the wind. If you are between two other boats, back both engines at a good rate, say two-thirds, or even full speed, to get the ship started. The wash of the screws will carry the sterns of both neighbors away and you will come away clean. Needless to say, slow down to a safe speed as soon as you are clear.

If the harbor is rather crowded, having backed away, but clear astern, it might be well to continue backing until you have plenty of room to turn. Only, be careful about crossing the bows of vessels at anchor. When going astern be careful how you use your rudder. A quick shifting of the rudder while you have sternboard may result in the rudder taking charge, on account of the pressure of the water on it, with a probability of a jammed steering gear, and perhaps a damaged steering engine.

Do not forget that when going ahead with full rudder you do not make ground to the side immediately. The ship, though turning, will range along its original direction of motion, and may even be set initially to the other side, due to the kick off of the stern, for the stern starts first, not the bow. We all know this truth, but occasionally forget it in the business of maneuvering.

In any maneuver try always to have an alternative in case your planned maneuver goes awry. A good habit of mind is to keep thinking, "Now if such and such a thing happens, what should I do?"

Under certain conditions do not hesitate to use an anchor to assist your landing. In a crowded harbor with a strong breeze or gale blowing, when you cannot get pointed into the wind to make a parallel landing alongside another boat, it is by far the best scheme to assist your turn by means of an anchor. Drop it so that you use as little scope as possible without dragging, and at such an angle as to be able to use it to keep the bow from crashing into your neighbor. Do not think it "bad seamanship" to use an anchor when it will prevent damage.

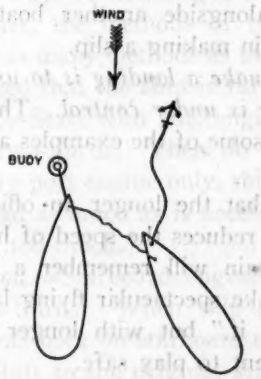

DIAGRAM B.

Diagram "B" shows that it is possible to use anchor and bow line to assist in turning by heaving in or checking both judiciously, at the same time using the engines to assist in turning. Be careful not to drag the anchor. This is most likely to occur when the ship is broadside to the wind. It is better to veer somewhat at that time and heave in when the heading is about as shown in sketch. When the stern is in far enough, and your lines are out, the ship may be heaved ahead to break out the anchor.

One captain turned his ship by getting out a bow line to the stern of another boat, let the ship swing to the wind and current, cast off and came alongside very nicely.

Do not forget, too, that your ship does not handle the same in light conditions as she does deeply loaded. This will be par-

ticularly noticed if there is any wind; your leeway will be greater in light condition.

SPEED

By speed is meant actual way through the water. You may often signal full speed on your engine-room telegraphs, if it seems best, but do not continue it long enough to get up much speed.

Speed is a good thing to use, only, (1) when you have to, and (2) when you have lots of room. Even in these cases do not use more than necessary.

If something goes wrong in a crowded harbor, such as jammed rudder or engine disabled, you will be harder pressed to win through without damage, if you habitually use high speed.

The same reasoning applies, with more emphasis, in making a landing, especially alongside another boat, or when there is something ahead, as in making a slip.

The ideal way to make a landing is to use only enough speed to be sure your ship is under control. This speed will depend on circumstances, as some of the examples already given serve to show.

I have observed that the longer an officer commands a destroyer, the more he reduces the speed of his approach. Nearly every destroyer captain will remember a period in his career when he loved to make spectacular flying landings. Very likely he "got away with it," but with longer experience he grew wiser, and was content to play safe.

And in this connection, if you misjudge your landing and see that you cannot avoid hitting, be sure to get the way entirely off the ship if possible; get out a line and hang on until you have swung. If one destroyer noses into another in coming alongside, an attempt to twist her around will almost invariably result in scraping along leaving a long trail of devastation behind. If you see you are going to be set against the corner of a dock, take your damage in one place, rather than to extend it for 15 or 20 feet or more along the side.

POWER

Often in an emergency a captain may take half-hearted measures to avoid collision or damage. Or, in turning, he unnecessarily delays by use of too little power. If he were the only one

entering harbor it would not matter much, but usually boats will be entering harbor in divisions or flotillas, and others will be delayed. Most of us know how exasperating it is to lie to at the harbor entrance, waiting for the chap ahead to get straightened out and in his berth.

Inasmuch as most destroyers have plenty of power, it may as well be used, only be sure not to get too much way on the ship.

Thus in turning in a limited space, it is foolish to ring up one engine one-third ahead and the other one-third astern, when you have enough power to ring standard ahead and two-thirds astern, changing either engine if too much headway is obtained. Then you will get around quicker and the *speed* through the water will be no greater.

Here are two ways of handling the engines of a ship turning in a limited space, the methods of two different officers—and there are nearly as many methods as there are destroyer captains. It will be assumed that the ship is turning to starboard:

First Method.—Start with port engine two-thirds ahead, starboard backing two-thirds. Then do not touch starboard telegraph *at all;* vary port engine only, shifting it to one-third ahead or standard ahead as much as is necessary to keep from forging ahead or astern too much.

Second Method.—Starboard engine back one-third; port engine ahead two-thirds. When ship gains too much headway, shift to *two-thirds* back on starboard engine; *one-third* ahead on port engine. Shift to the original setting when you gather too much sternboard. Continue like this, making no other changes except necessary rudder changes. In this case the command may be simply "reverse." There is little possibility of giving the engine-room the wrong signals.

Take your pick, or choose your own method!

It must be clearly understood by the throttle men just what the captain wants when he rings the engine-room telegraphs. A certain go ahead speed should be established as a maneuvering "standard speed," say 18 knots (15 knots will probably be better for 750-ton destroyers). Then you have one-third speed, six knots; two-thirds speed, 12 knots; full speed, 23 knots (five knots greater than standard, which is often designated for full speed in destroyers).

It is more difficult to base backing speeds on revolutions, and most destroyers have designated *pressures* for one-third, two-thirds, and full speed astern. No arbitrary pressures can be given, but the backing pressures of the ship should be so arranged that with one engine backing one-third and the other ahead one-third, the ship will move very slowly ahead.

A very important point arises in this connection. The throttle men may do one of two things when a backing signal is received: (1) Open throttle wide so that gage registers the designated pressure immediately, then throttling to keep the pressure there; or (2) he may open it gradually until the gage registers the desired pressure.

Of these, to my mind, the first is preferable in maneuvering, though perhaps the second is better from an engineering point of view.

However, in maneuvering, the kick given by the engine churning when first started back is often of exceedingly great help to the ship handler, and that effect is greatest if the throttle is opened wide at once. Furthermore, the result of a given signal is more apt to be the same to-day and to-morrow, a most desirable thing. For if the engines perform differently at different times, when the same signal is rung, the captain will truly have a terrible task to "learn by experience."

LACK OF CONFIDENCE

This hardly needs discussion, it is so evident, as in everything we undertake, that confidence is half the battle.

In passing, it may be remarked that of two officers of equal ability starting out with their first commands, if one has the luck to make a perfect landing under difficult conditions, on his first attempt, he will usually continue to make good landings; whereas the other may slip up, knock down a few stanchions, dent in his bow, or knock a hole in the dock, and it will take a long time for him to get to normal.

USE OF LINES

It is not within the scope of this article to go into details of how to handle the lines under all circumstances. But the proper handling of lines in connection with the proper handling of engines and rudder is the truest test of a seaman.

The most useful lines are the forecastle spring and the after spring. Next to this a breast to the capstan, and a breast aft, the latter to be made fast only when the ship is sprung in, or worked in by the engines, to the proper position.

The main thing is to obtain intelligent cooperation between the captain and the officers or men in charge of lines. To this end the latter should be indoctrinated so that they will know what to do without the necessity of signals or of bawled out orders.

When a "parallel" landing is to be made, *under good conditions,* the smartest method is for the captain to hold all lines on board until the ship is nearly abreast her proper position (and nearly dead in the water), toot a whistle, throw out all lines simultaneously on this signal, order engines secured, turn over the securing of the ship to the executive officer—and go below.

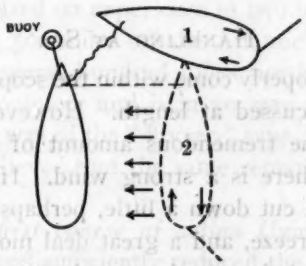

DIAGRAM C.—Port Screw Ahead; Starboard Backing; Rudder Full Right.

But when conditions are such that a certain amount of work must be done to get the ship alongside, the people handling the lines must know what the captain wants. An improper use of lines often will get things badly mixed up.

The following method of getting alongside a dock or vessel, when it is impossible or inconvenient to make a "parallel" landing, is especially good in landing when an offshore breeze is encountered. Having once tried this method the writer has used it continuously, and considers it a very pretty way of making a landing:

Proceed fairly directly to your assigned berth, and get your bow close enough to get out a line as in Diagram C, position (1). Keep this line entirely slack and twist the ship around to a heading parallel with the dock or ship with the engines, starboard

engine backing say two-thirds, port ahead two-thirds, and rudder full right. Change *one* of these engines in order to prevent going ahead or astern. It's easier to remember what you are doing if you only use one. When you are about parallel, (your bow will have paid off by this time) take line to the capstan and heave round. Then by proper manipulation of the engines (starboard backing, port ahead) and the line, the ship will breast bodily in crab fashion, and all that will be necessary at the last will be to get out more lines and secure. When you are parallel, the power of the engines must be reduced, as they kick the stern in faster than the capstan can pull the bow in. When about 10 feet away, stop everything, otherwise you will come in with a decided bump.

This same method may be used in getting away from a dock against an onshore breeze if there is a buoy or something to run a line to.

HANDLING AT SEA

This does not properly come within the scope of this article, and so will not be discussed at length. However, emphasis should be placed upon the tremendous amount of leeway a destroyer will make when there is a strong wind. If the wind is ahead your speed will be cut down a little, perhaps as much as 10 per cent in a strong breeze, and a great deal more in a gale. Most of this is probably due to the sea, however. With the wind about abeam or a little forward of the beam, you may find yourself 40 or 50 miles to leeward of your dead reckoning course in 24 hours. With the sea on the quarter, however, the ship will yaw so much, the stern being pushed to leeward, that the leeway may be counterbalanced, and you may even find that you have crept slightly to windward. No rules can be laid down concerning this, for it depends on the character and period of the sea, in addition to the strength of the wind.

With a rather heavy sea dead astern one would think the ship would be driven farther than the dead reckoning would give. This may often be the case, but to a much less extent than we would suppose. This may be due to the climbing up hill and down hill a destroyer would do under these conditions.

IN HEAVY WEATHER

Here are the different courses of action open to a destroyer forced to heave to in a heavy gale:

1. Head into sea, or with sea two points on the bow, at the lowest possible speed, lee screw making more turns than the weather screw, to keep the ship from falling off.

2. Take the position the ship would naturally take, engines stopped or moving slowly ahead.

3. Sea astern or slightly on quarter, "running before it" at fair rate of speed.

4. Sea astern or slightly on quarter, engines turning just enough to keep steerageway.

Every time two or three destroyer captains begin to discuss bad weather and how the ship should be handled in a hurricane, you will hear two or three different expressions of opinion, based on actual experience.

So my opinion based on experience in two well-known howlers, one January, 1912, 500 miles off the Atlantic Coast, the other in December, 1917, several hundred miles northwest of Cape Finistere, is only my opinion, and is in no way authoritative. And both times the boat was of the "flivver" type, *i. e.*, 700- or 750-ton boats. But it is believed that the same remarks will apply to the larger boats.

Now as to the *first course of action* (lying to, heading into the sea): With speed sufficiently reduced the ship will ride quite well, though pitching violently and occasionally taking a sea. If you head dead into it you are likely to duck under an exceptionally steep wave and ship a huge sea. It is better to keep about two points off. But it is necessary to maintain a certain amount of speed to steer, and the greater the force of the wind the greater the speed necessary. And the greater the speed, the more seas will be shipped, and the more the ship will pound. In my one experience of trying this method the ship was pretty badly damaged.

Nearly all the destroyers doing convoy work had broken frames forward, the result of pushing the ship against heavy seas. This is a different condition from that under discussion: the necessity of staying with the convoy in the war zone making it necessary frequently to steam into a sea at too great a speed in ordinary rough weather. But the same liability to damage exists in heavier seas and with more moderate speeds.

The *second course* (lying to in a natural position), while safe enough, as far as danger of swamping is concerned, is so utterly uncomfortable and hard on the personnel, due to violent rolling, as to preclude it from consideration, even if there did not exist the danger of rolling out the masts, smoke-pipes, and perhaps even rolling the boilers out of their saddles. As a matter of fact, destroyers have shipped heavy seas in this position. A sea sweeping across the deck of a destroyer is not a pleasant thing.

There remains, then, "running before it," and "lying to" with bare steerageway, sea astern or on the quarter.

Perhaps I have never given the former (running before the sea) a good trial. In the storm of December 17, 1917, on the *Reid*, lying to with sea astern, an increase of speed caused greater yawing, with threatened pooping, and we slowed down very soon.

We found it best to keep the sea a trifle on the quarter, in which position, with the use of oil, we rode beautifully. The ship yawed a bit, and the fantail was splashed with spray, but no dangerous seas broke on board. In some kinds of heavy seas, a destroyer can doubtless run at good speed, but I believe that, all things considered, it is safer when riding out a "storm sea" to steam as slowly as possible.

We tried heading into the sea, and did not fare very badly, but after shipping one or two seas it was decided to turn again, and keep the sea on the quarter.

With a destroyer there is no sense in waiting for a propitious time to turn, for a turn of 180 degrees in a heavy sea is a long operation. If done at slow speed, however, she will probably bob up over the sea like a cork, but she will be well shaken up during the operation, and there is always the danger of being swept by a sea.

The *Reid* sustained her greatest damage when speed was increased in order to turn and avoid a ship suddenly sighted a short distance ahead. This increase was from about six knots to about 12 knots. When the sea was nearly abeam, one wave swept over the deck, taking with it various items, such as boats, chests, potato lockers, etc., also, worst of all, our engine-room ventilators. A second sea coming over went down these openings, resulting in an engine-room half filled up, water entering lubri-

cating oil tank (having broken the gage glass) and directly afterwards hot bearings!

After this we had to keep the ship dry, and it was necessity that forced us to continue with the sea astern and continue using oil, which was of great value in preventing breaking seas.

Every destroyer captain should be very familiar with the "Laws of Storms," and should practice forecasting the weather. With Knight and the "Sailing Directions" for the particular locality at hand, one can develop into a first-class weather prophet, depending of course on your station, for the weather in some parts of the world is more difficult to understand than in others.

I have been told that a number of years ago two British destroyers went through a harrowing experience in weathering a typhoon in the China Sea. Their experience and lessons drawn therefrom were written for an English publication as being of great interest to the public, and especially to seamen.

But a careful reading of the article showed that these boats had entered the edge of the typhoon, had run out, and then were caught again when it recurved, this time passing through the center of the typhoon, encountering terrific winds and seas. The point of this is, that if they had been more familiar with the characteristics of cyclonic storms, they would have avoided the worst part of their experience.

AN EXAMPLE OF DIFFERENT WAYS OF HANDLING A DESTROYER

Diagram "D" shows roughly the Anacostia and Potomac rivers, and the Washington Navy Yard. It was quite easy here to make a landing, but somewhat difficult to get away. Type of destroyer: Coal-burning, 700-ton type. The nature of her duty was such as to make it necessary to reduce the time wasted in mooring and unmooring to a minimum.

The ordinary method of "shoving off" depended on the tide. If it was ebbing, the bow was allowed to go out a little, engines started ahead, and when clear the ship was twisted around, ready to proceed down the channel. If on a flood tide, the stern was allowed to go out a bit, the ship backed clear and then turned. This was more difficult, and it was usually necessary to make a complete 180-degree turn, on account of the flood tide carrying the ship upstream. It must be remembered that this was a "700-

tonner" and required surging back and forth, shifting the rudder, and working pretty hard to get around. A "1000-tonner" would have had less difficulty in turning.

A better scheme was to wind the ship at the dock. This was not difficult, especially with a flood tide, for then the stem could

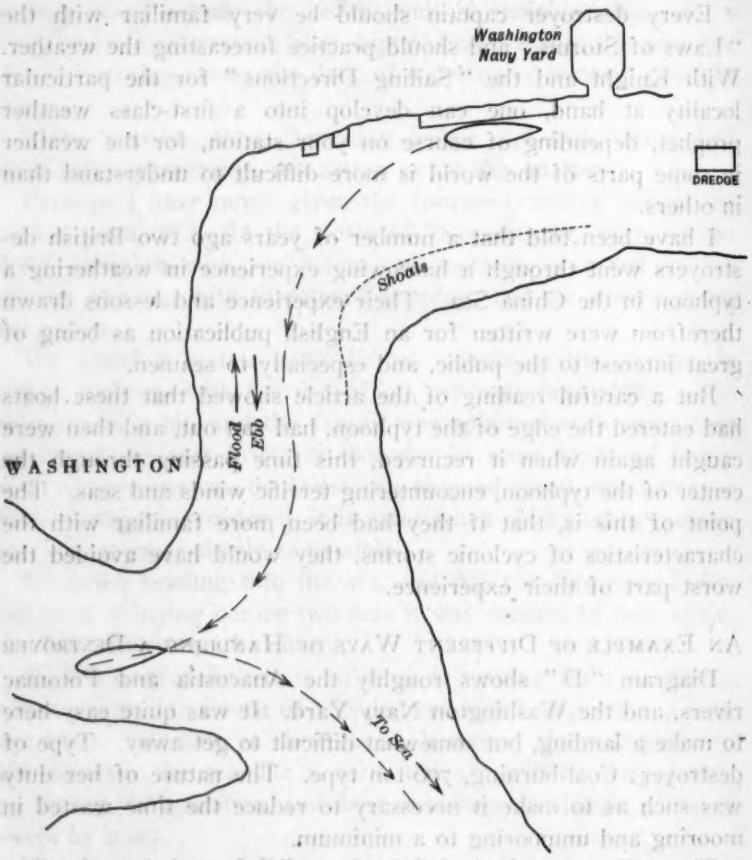

DIAGRAM D.—Potomac and Anacostia Rivers, Showing Navy Yard.

be held fast against the dock, until nearly around, then the ship backed enough to clear before going ahead.

With ebb tide it was not difficult, except that more care had to be taken to keep the propellers and rudder from touching the dock. In general, the current did practically all the work in this case, the engines only being used to keep the stern clear of the dock.

The next method tried was to wind the ship upon arrival. Coming in on a flood tide, the stem was placed against the dock and held fast, the tide, assisted by " twisting " with the engines, turning the ship end for end. This permitted a " clean get away," when it was time to go.

The last method was to back away from the dock, and, steering by engines and rudder, backing into the Potomac River, where it was only necessary to go ahead and down the river. This is shown by dotted lines.

These various operations were timed, and it was found that the last method saved several minutes.

CONCLUSION

Most of the foregoing remarks on the handling of destroyers are concerning " the little things that everybody knows," but in nine out of ten cases of damage or poor ship handling these little things are responsible. This article is not based on theoretical considerations, but on actual happenings.

It need not be assumed that a destroyer captain must analyze the forces at work while he is maneuvering his ship, or to have any " rule-of-thumb " methods. More likely, if he has gained some degree of expertness by practice, he will develop a sixth sense; he will handle the ship by the " feel " of it, as it were.

It may be remarked that in handling a destroyer it is best to take station where you can see the water close to the side. In this way you can judge your speed much better than by watching the beach or another ship.

Finally, be sure to give your junior officers, especially the executive officer, a chance actually to handle the ship under good conditions. In this way they, too, will get the " feel of the ship," and when the necessity comes for them to handle the ship in your absence they will have some degree of confidence to help them.

Remembering that there are many different ways of doing it, do not insist on their doing it exactly your way, and do not " butt in " except to avoid disaster. It is much better to talk over the whys and wherefores afterwards. I doubt if even the most phlegmatic " mate " could do well under the fire of his captain's criticisms.

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SOME NOTES AND SUGGESTIONS *IN RE* NAVY PAPER WORK

By LIEUT. COMMANDER F. WELDEN, U. S. Navy

After reading Admiral Fiske's article entitled "The United States Naval Institute" in the February issue, 1919, I am prompted to burst into song on the subject of naval paper work.

My first experience in navy paper work was some years ago on a beef boat where I was acting gunnery officer of a small battery and it was necessary for me to make all reports without the aid of a regularly assigned yeoman. This work by the way was terminated by turning in all gunnery department stores and most of her battery to the navy yard when the ship went out of commission.

My experience while on this job led me to believe two things; one of which was, that the reports were so detailed and so numerous that large inaccuracies could be submitted without being detected and corrected. I make this statement because, as I discovered, there had been many erroneous reports submitted and I suppose I added to them, without, to my knowledge, anyone getting called for them. The other observation was that in my acquaintance with ordnance forms I found that the man who proofed the print had never been guilty of ever making up one of these forms on a typewriter, since they oftentimes have to be put in a machine three separate times to get the data on them in the proper place and at that the numbers involved very often run over in the next column.

After this first experience with paper work I had no further details which involved making reports except such things as hull boards, surveys, court martials, etc., until four years later, when I was ordered to a naval base which had been established during time of war and about three months previous to the signing of the armistice.

Needless to say that under these circumstances, with almost all the officers, reserve force and the same with the enlisted personnel, the paper work was far from pure. Unfortunately my experience had only been that previously related and I was handicapped, but I wish to make the following observations: I believe that the most serious fault with navy paper work at present is, that even officers of considerable experience and frequently of lengthy service had depended too much on the old-time chief yeoman and as a result, things which should be clear enough to anyone of any intelligence and average experience are often very hazy and cloudy, since up-to-date publications and instructions have not been issued, such as the yearly rules for battle practice.

Under this heading I should like to note that I believe as a "First Aid" the navy must have a standard method of correspondence based on battleship organization and expanded or contracted for other ships and stations as the case may be. This is undoubtedly contemplated in various rules for correspondence and instructions, but is not printed to the best of my knowledge in such form that any officer or yeoman can have a copy at any time he wishes it.

If standardization is worth anything at all, it is believed that navy paper work should surely be standardized and to this end there should be a standard system of procedure of correspondence involving at least the following:

(a) Each ship and station in the navy should have a central filing and mailing room.

(b) All incoming and outgoing mail should pass through this department with the possible exception of medical and supply correspondence not pertaining to the other offices aboard ship or station.

(c) Every department of a ship or station should be given a file letter, much the same as a fire control circuit is assigned letters.

(d) That a universal set of file numbers be adopted.

(e) That every letter coming to and from a ship or station be made a matter of record, and copies retained in the central file, except routine correspondence not necessary for record.

(f) That a cross index system in connection with the files be adopted on each ship and station and each letter cross indexed under as many subjects as possible in order to facilitate the accessibility of all letters on file, and likewise all Bunav. Circular Letters, Alnavs, Alatlantics, etc.

(g) That every ship and station adopt a color system of paper, such as; original—white, file copy—green, desk copy—pink, tracer copy—yellow. The file copy is to be retained in the central files on each ship or station, pink copy to be retained by the department of origin for a desk copy, yellow copy to be retained by the central files if a reply is necessary.

(h) That the central filing and mailing room number consecutively all outgoing correspondence, keeping a record of it in the outgoing mail book.

(i) That all correspondence show an initial letter of the department of origin and the initials or sign of the yeoman preparing the same.

(j) That the distribution be shown on all copies. This to include all printed forms.

(k) That all correspondence show immediately following the office letter and yeoman's sign the date when a reply is expected or (O) meaning no reply is expected.

(l) That the month shall not be numbered in any correspondence, but will be abbreviated as, Jan., Mar., since there is a great deal of confusion resulting from placing the day of the month before the number of the month.

(m) That the file copy shall at all times be a *signed copy*.

(n) That every signature should be written out on a typewriter, including the original, so that anyone who reads may know whose name it is.

It is believed that if a survey be made to determine the number of obsolete forms now in use that a considerable number could be done away with absolutely and that others could be revised so that one form would answer several purposes. While on this subject it is earnestly requested that all forms be made up to be filled in with a typewriter and as nearly as possible should complete the action by the use of one form. This would tend to reduce the number of signatures required such as, at present, on misconduct reports involving a loss of pay, which required seven signatures from the commanding officer, two from the executive officer, two from the medical officer and one from the supply officer, making a total of twelve signatures from officers that should ordinarily be engaged in more profitable work. To be of real value forms must be easily understood and should be complete in themselves, but need to be constantly corrected and not allowed to become *obsolete*.

It is believed that the present enlistment and enrollment records should be made uniform. At present there are many different marks and modes of service records, including five different colors, which makes it rather confusing to any yeoman to discover whether he is proceeding according to the latest practice or not. In this respect it is suggested that color should show the new editions in which the latest instructions for keeping enlistment records would be found. It is suggested that the present enlistment and enrollment records are not entirely satisfactory and it is believed that a loose-leaf system could be inaugurated so that the records would be of more value than now,—mostly a conduct report. Surely a man's photograph should be carried in his record, and that there should be some place in the record whereby the duty actually performed by the men should be entered, whether it be captain of the head or swabby of the lower deck. This can probably be accomplished by a skeleton record or a part of the loose-leaf record in the hands of the division officer.

After looking over a great number of service records that have been kept under various circumstances and various conditions at this base, one is not surprised to see records which contain no entries whatever for a period of six to eight months, except possibly the time of transfer, although even this is frequently omitted. The present records are full of Ts, Rs and CRs and "Less Than One Month," but it fails to show the time of reporting for duty even though the time of transfer may be a long period. Numerous places in the record which require entry for special reasons, such as conduct, leave, other misconduct and checkage of pay are a direct invitation to *inaccuracies* in records.

It may be pertinent to suggest the questions as to whether or not the present system of carrying men's accounts is the best. Would it not be possible to give the man a book in which the government enters an account, the same as a bank and from which he can write checks and present them for payment at any time during office hours of the supply officer.

While on the subject, it is believed that something should be done to allow officers and offices to keep up to date on Alnav. messages, Circular Letters and General Orders, which it is suggested should be published at least quarterly and a complete edition should be sent out yearly. Bureau of Navigation Annual

Circular Letter consists of a great deal of information which is believed should be included in the order governing advancement in rating, which at present is G. O. 63, "Instruction on Board Ship." This General Order, however, is deplorably out of date and does not answer the requirements, especially for an emergency as has recently confronted the navy. There is entirely too much "A to N" and "N to Z" and not enough "how to do" and "Can you do?"

It is noted that electricians (radio), quartermasters, machinist mates, now have a letter to designate their specialties and it is suggested that a letter could be used to advantage in many more ratings, particularly the rating of yeoman.

It seems to be worth while to encourage men to qualify in more than one rating and a small amount per month for each rating in which they are qualified would probably prove a correct incentive. This should be especially valuable to different yeoman stenographers and would encourage officers in dictating rather than compiling.

In summation of the above it is believed that the best instructions now issued by the Navy Department are the rules for battle practice, which give instructions to all classes of vessels as to what practice must be held, how they are held and what reports must be made, and include a *sample copy* of each form that is necessary so that if for any reason the forms are not available an officer may study the sample forms and if necessary make up copies on a typewriter or have them printed. It is believed that if this can be done for such a thing as battle practice, it is feasible to issue a booklet, annually if necessary, on standard instructions for correspondence. Instructions as to procedure of transfer, receipt, checkages, sentences of summary courts martial, etc., and include a list by offices of all reports required or a reference with a copy of each report in this booklet.

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THE PRINCETON NAVAL UNIT

By Rear Admiral Caspar F. Goodrich, U. S. Navy

This brief article is not designed to give all the details of the work of the Princeton Naval Unit, but only a few of them, thought to differ from those in other naval units, all of which latter were conducted on general lines laid down by the Bureau of Navigation. The members prosecuted the studies prescribed by the University faculty for the gaining of the degree aimed at individually, while the naval instruction and discipline were the care of the commandant. In my case, there was no commissioned officer to assist me. I was, however, allowed one chief yeoman. Fortunately for me, he was competent to conduct military drills, having previously had a long experience in these matters. Also, he was helpful in the routine of the office within the limits of his capacity and knowledge.

The theory of navigation, seamanship, ordnance and gunnery were taught by college professors of exceptional ability. Practical work in gun exercises and demonstration in ordnance fell to the lot of a keen chief gunner's mate after the somewhat belated receipt of the necessary material, including some machine guns and a 4-inch loading rifle. This man had the happy knack of enthusing my lads almost as much as if he had a 14-inch gun at his command. I wish to acknowledge my indebtedness to Chief Yeoman J. G. N. Mitchell and Chief Gunner's Mate W. F. Buckley for loyal support.

Professor A. G. Mayor, a nephew of the late Rear Admiral Louis M. Goldsborough, U. S. N., assisted by Professor R. S. Dugan, the astronomer, kindly assumed charge of navigation, for which task they are eminently qualified. As the former has for years cruised about the world in a sailing vessel, he was able also, to teach seamanship. Here he was helped by Professor

Ulric Dahlgren, grandson of the late Rear Admiral John A. Dahlgren, U. S. N. In Professor Dahlgren's veins runs hereditary salt water. Later, when some cutters and whale boats arrived, he greatly aided me in boat drills conducted, perforce, by myself.

Professor L. P. Eisenhart, the mathematician, handled the subject of theoretical ordnance and gunnery in masterly fashion, acting, moreover, as liaison officer between the university authorities and me. I may here remark that my relations with these authorities continued to the end absolutely flawless. These gentlemen did all in their power to facilitate my work, freely acceding to my every request. If they entertain towards me the same feelings of regard as I do towards them I shall have good reason to be proud.

My unit was comfortably quartered in dormitories hard by an office assigned me in the gymnasium. Thus they were accessible at all times for inspection and were close to the place of formation.

So much in the way of preamble.

Possibly, nay probably, my disciplinary methods will be regarded by the majority of my readers as execrable. I should welcome universal applause, naturally, but really I would not alter those methods by a hair's breadth to win it. I was trying an experiment. As the experiment succeeded perfectly, at least to my satisfaction, I am well content.

At practically the first gathering together of the unit, I addressed the members substantially in these words:

You are training to become officers in the United States Navy. Absolute truthfulness and honesty in all your dealings is obligatory as well as diligence in your work, respect to your seniors, devotion to the service and an upholding of its traditions. I propose, with your permission, to treat you as officers. If, however, you compel me to treat you as school boys I am quite ready to do so; it all depends upon yourselves.

Therefore, when reports for some minor infractions of discipline were made to me, I adopted the rule of asking the man involved whether the report was true. If he replied that it was in error, I accepted his statement without question and dismissed his case at once. I knew instinctively that, if he lied, his colleagues would make his life very unpleasant. Should the report imply moral turpitude, I allowed him to select one judge, the battalion commander appointed a second and the two chose

a third. The court thus formed investigated the case and handed in to me its finding and recommendation. In one case, I was led to dismiss the man from the unit and transfer him to the nearest receiving ship. In another, although the lad was guilty, clemency and a chance to rehabilitate himself were urged. This plea was accepted with happy results.

Demerits I rejected as appropriate to primary schools, not to a class of officers. In lieu thereof, I sought a "punishment to fit the crime." For example, one lad, whose shoes were not polished, was directed to write me a report on the shoe blacking establishments of Princeton. This report was so well done, in such good spirit and with so delightful a touch of humor (he discussed the relative merits of Greeks and Negroes in this employment) that I sent it to the boy's father who enjoyed it as much as I. I may add that cases of unpolished shoes were conspicuously absent thereafter. If the average youth dislikes any one thing in particular, it is writing a report. The instance referred to had a widespread and salutary effect.

One member, given to repeated talking in ranks, heard this pronouncement: "Since you are so fond of hearing your own voice, you shall stand in front of your company and recite aloud the Star Spangled Banner." Needless to say there were no more complaints of this nature. Incidentally I may remark, that the National Anthem was memorized by all. Every now and then it was the password to liberty.

At the very first lecture, I spoke to the unit in somewhat this fashion: "I observe with great displeasure that some of you young gentlemen have failed to obey my order always to bring notebooks and pencils to every recitation. You will each therefore write me a letter explaining your neglect and you will include in your letter a résumé of the sermon preached yesterday in the College Chapel by President Hibben." The neglect mentioned was not repeated.

One lad had not made up his bed by the hour appointed. To him I remarked, "Is not this afternoon a half holiday?" "Yes, sir," was the reply. "Very well, then, you will have your bed made up and your room in perfect order by 2 p. m. You will report the fact to the officer of the day, who will inspect. If all is in good shape, he will immediately pull your bed clothes apart and turn your room topsy-turvy. You and he will repeat

your several operations three times." This remedy proved most effective. These specimens of disciplinary methods are taken at random from a number—fortunately not large.

At the outset, I warned my youngsters that I should ask them many questions which might at first seem childish and should make them do many things which they would think foolish, my object being to cultivate their powers of observation, adding that when any one of the unit, later, on joining his ship, should be noted as mentally alert to a marked degree, seeing at once what others only looked at and taking in everything in sight, he would at once be recognized as a "Princeton man." To this end I sent out four observation parties, one to each compass quadrant, nearly every afternoon to make a hike covering about five or six miles. On their return they would be quizzed somewhat after this manner: "What kinds of road did you go over? What kind of fences did you see? What trees along the road? How many cows, sheep, pigs did you see? What sort of teams did you meet? How was the wind blowing? What proportion of blue sky in tenths?" etc. Each man was marked on the Naval Academy scale according to his answers. Meeting a group, I would fire at them such puzzles as these: "How high is that tree? How wide this road? How long is the gymnasium? How far is it from this building to that? What kind of trees line such and such a path? How many haberdasher shops in the two blocks on Nassau Street facing the University? The lads never knew what was coming next and they were distinctly on their toes whenever I hove in sight. One instance is so amusing as to be worth the telling. A company was at rest on the drill ground beside the railway. Calling out of ranks some half dozen or so men, I told them that railway metal was graded by the number of pounds per running yard, that, the last time I had occasion to inquire into the subject, the heaviest rail rolled was 110 pounds but that doubtless the weight had increased since then. "Go over to the railway, look at the rails, return and give me your estimates of weight." This they did. I may say that their guesses were quite close to the real figure. Then said I to them, "If you had looked carefully you would have seen that the weight of each rail is stamped upon it." A more crestfallen lot it would be hard to imagine.

It is notorious that competent messengers are rare. Inattention or indifference is the cause. I instituted a training in this respect. For example, while the battalion was at rest, the captain of Company A would write a message, call up one of his men and read it aloud twice, slowly and distinctly. "Take this message to the captain of Company B." The latter would write the message *as verbally delivered*, and send the paper to the captain of Company A. This procedure was repeated all down the line. It was astonishing to note the errors at first made in this transaction, but these errors diminished rapidly with practice, even when the messages, at the beginning short and simple, grew longer and more complex. The lads developed closer attention as time went on. Of course they were marked for accuracy in this work.

Now what was the result of this unusual form of instruction? Several members of the Princeton faculty have told me that never has there been in this University so keen and mentally wide-awake a set of men as those of the Naval Unit. Again, the Professor of Architecture informs me that he has, perforce, to teach largely by means of photographs. Since he cannot bring St. Peters in Rome or Canterbury Cathedral into his lecture room he must resort to pictures of them. Usually it takes his class a whole year to learn "how to read a photograph," yet the men of the Naval Unit acquired the trick in two weeks. It seems incredible—yet that is what he said. As there can be no substantial difference between the men of my unit and the rest of the student body it follows that the former merely learned the use of their eyes.

I have always been of the opinion that cadet officers at the Naval Academy should not be permanent. The practice gives all the experience in command to a select few. At Princeton I had an opportunity to try out my own ideas under this head. The unit was formed into a battalion of four companies. The cadet officers, upon organization of the battalion, were chosen for their qualities in leadership as gathered by me from the information available. I hasten to say that they justified their selection. But I at once spoke to the unit in somewhat these words: "The most essential thing in an officer is the faculty of command. This can only be developed through practice. If it were possible, each one of you belonging to the First Division (designed to graduate at Christmas) should have a trick as

battalion commander, but as you know, you are too many and the time is too short. In a couple of weeks I shall appoint a new set of cadet officers, but as I am determined that none of you shall ever be able to accuse me of favoritism, of giving this inestimate opportunity of learning how to command to men I hold in special esteem, I shall put into a hat the names of those of the division now serving in the ranks. These names will be drawn by a disinterested person and a roster made absolutely by lot. There are fourteen cadet offices. The man whose name leads the roster will be the battalion commander for two weeks, the second the battalion adjutant, etc. At the end of a fortnight numbers 15 to 28 will succeed them, and so on to the end of the term. If any one of you fails to get a high place, do not blame me. I shall have given every man the same chance. Luck shall decide, for or against you." I have every reason to be satisfied with this innovation. Each man knew in advance the place he was to fill and sought to prepare himself for his duties. There existed a hearty sense of co-operation all round and there was no lack of snap in drills, for each endeavored to do even better than his predecessor.

One case is worth citing as illustrating my own attitude towards my men. A certain member, a thoroughly nice, manly chap who had drawn the lot of company captain, came to me and begged to be excused from that duty on the score of his lack of sufficient military training. This request I flatly refused, saying "Blank—you have an opportunity of showing to yourself and others of what you are capable, an opportunity which may never again come to you in all your life. Your friends in the first detail will tell you what to do. Put on a bold face and pretend you know the whole game. Never mind mistakes, we all are guilty of them. If I should relieve you now, in days to come you would never forgive me." Of course he made good and when later a chance occurred to prove his gratitude he seized upon it eagerly—but that's another story. Disappointment was doubtless experienced by some who drew the smaller prizes in the lottery, but all recognized the justice of the scheme.

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DROP THROUGH PUMP VALVES

By COMMANDER BRUCE R. WARE, JR., U. S. Navy

The loss of pressure through the suction and discharge valves of the various pumps on board ship is not given sufficient consideration. As a rule, if a pump runs when steam is turned on and "really" *does* pump the water or oil as the case may be, it is taken for granted that everything is all right. It may be, however, that as high as a quarter of the power input is being used to operate the valves. The engineer officer who wishes to obtain

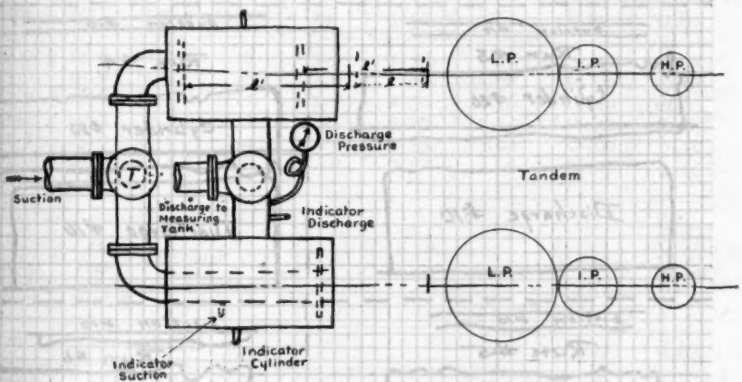

FIG. 1.—Test Layout for Drop Through Valves.

economy should become familiar with the pumping heads and pump speeds for his pump requirements in order that this loss of pressure may be reduced to a minimum.

The theory involved is simple: A pump, in order to receive water into its cylinder, must expend energy in raising the suction valves and in setting in motion the water in the long suction pipe. The pump has also to discharge the water from its cylinder and to do so it must expend additional energy in lifting the discharge valves. This expenditure of energy causes a decrease in the net work.

In studying this loss, an indicator diagram may be used to show the pressure inside the cylinder on the suction and dis-

charge strokes. In order to investigate the drop through pump valves an ordinary direct acting pump was rigged, as shown in Fig. 1. There was an indicator attached to each cylinder; one

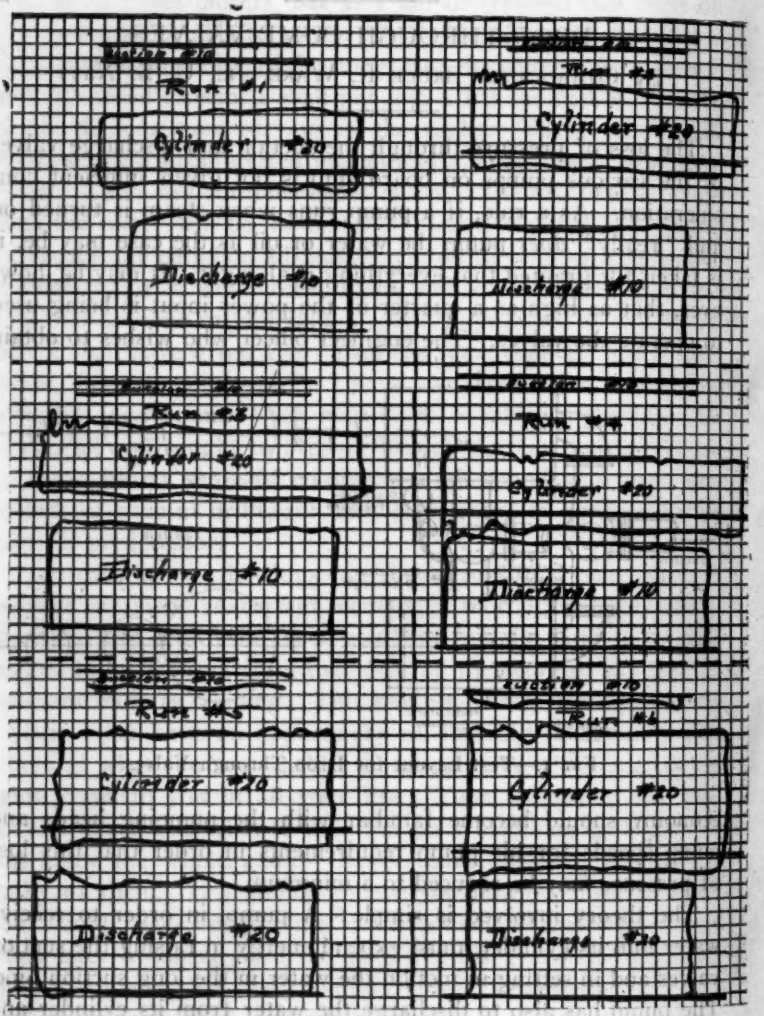

FIG. 2.

on the discharge and one on the suction. The indicator diagrams for six (6) runs are shown in Fig. 2. The test log record sheet is shown in Fig. 3.

No. of run	Time in sec.	Lbs. of water per sec.	Cu. ft. of water per sec. Q	Lbs. of water per hr.	R. p. m.	Length of stroke ins.	Pres. corres. to barometer #/□″	Suction pres. #s/□″ abs.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	300	12.77	.204	46,000	6.0	11–9	14.80	13.6
2	300	14.93	.239	53,800	9.5	11–9	14.80	13.8
3	300	40.27	.745	145,000	17.0	11–9	14.80	14.0
4	180	71.00	1.135	255,500	27.5	11½–8	14.80	14.0
5	180	76.80	1.229	276,200	27.5	13–10	14.80	13.6
6	180	79.90	1.279	280,100	28.0	14–9	14.80	13.7

Cyl. pres. intake #s/□″ abs.	Cyl. m. e. p.	Disch'g m. e. p.	Drop suction valves #s/□″	Drop disch'g valves #s/□″	Drop suction valves in feet of water	Drop disch'g valves in feet of water	$\sqrt{2gh_s}$	$\sqrt{2gh_d}$
(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
13.0	14.8	11.7	.6	3.1	1.38	7.13	9.45	21.45
13.0	15.0	12.4	.8	2.6	1.84	5.98	10.90	19.65
13.0	12.6	11.4	1.0	1.2	2.30	2.76	12.40	13.35
11.7	10.3	9.8	2 3	.5	5.29	1.15	18.30	9.85
11.2	25.0	24.6	2.4	.4	5.53	.92	18.90	7.70
11.0	25.0	24.8	2.7	.2	6.22	.46	20.00	5.55

$\frac{Q}{\sqrt{2gh_s}} = KA$ suction	$\frac{Q}{\sqrt{2gh_d}} = KA$ disch'g	Combined losses %	Piston speed in ft./sec	No. of run
(19)	(20)	(21)	(27)	(1)
.0216	.0095	.84	.0833	1
.0219	.0121	1.00	.1320	2
.0520	.0483	.68	.2367	3
.0620	.1152	.79	.3718	4
.0650	.1596	.28	.4385	5
.0639	.2304	.16	.4480	6

FIG. 3.—Test Log Record Sheet.

Before proceeding to deduce results from the data recorded, it may be anticipated that for the case Fig. 1, the intake pressure should be lower than that of the atmosphere, due to the necessity of lifting the suction valves and to starting the flow. Work must also be spent in opening the discharge valves, so it may be expected that the average pressure discharge will be less than the mean effective pressure in the cylinder on the discharge stroke.

The amount of drop may increase or decrease with an increase or decrease in the speed of the pump, or vice versa. However, the faster the pump runs, the more continuous the flow of water into the cylinder and the less energy will be lost in moving the

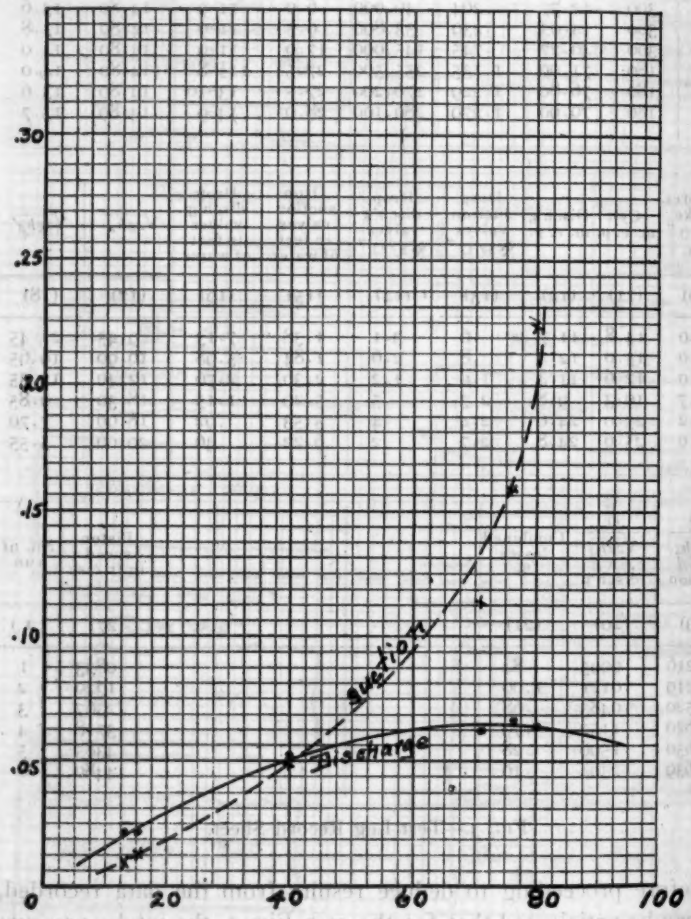

FIG. 4.—Pounds of Water per Sec.

column of suction. On discharge, the faster the pump operates, the larger the volume of water to be discharged, and this will necessitate higher mean effective pressures in both cylinder and discharge. In order to handle the increased volume as the pump

speeds up, valves must be worked faster, and as the valve seat area is a constant the amount of "lift" (opening) only need be considered. As volume has three dimensions it is seen that the opening will increase with the cube and the energy lost is proportionally less. The loss will be still proportionally less as the pump speed increases, due to the stroke of the pump being in feet and the valve opening being in inches.

In pumps where the valves operate against springs, the loss through them will be greater.

The amount of water discharged through an orifice is proportional to the area of the orifice, the velocity of the flow and the shape of the orifice. The equation $Q = K \times A \times \sqrt{2gh}$ shows this relation. Therefore, if the amount of water discharged by the pump, Fig. 1, is measured, Q will become known; by measuring the area of the valves A is obtained. It is now necessary to relate the factor $\sqrt{2gh}$ to the condition of a pump: the cylinder is full of water, the piston advances at a certain speed (this is piston speed in feet per second) and forces the water through the valves into the discharge line to the measuring tanks. The amount of drop through the valves is equal to the difference in pressure shown by the indicator diagrams obtained and will be the desired value of h.

The only factor in the equation that requires special consideration is the coefficient K. The type of valve, the length of pipe, the inside projections, are all factors which affect K. Its value should be determined for each pump on board ship by running a short test. To make the results of Fig. 3 general for use on board ship the relations will be calculated and plotted for a value of KA. The coefficient of discharge K may or may not be constant. For varying pump speeds it cannot remain constant for the amount of valve opening will vary.

The data on the test log record sheet, Fig. 3, is explanatory of the method of calculating results. The amount of water measured during the run is divided by the time of the run in seconds and the value of Q obtained. If the water has been weighed, dividing by 62.5 will give Q in cubic feet. In the test the temperature of the water was recorded in order to ensure using the correct value of the conversion factor. From the revolutions (6) and length of stroke (7) the average piston speed in feet per second (27) was

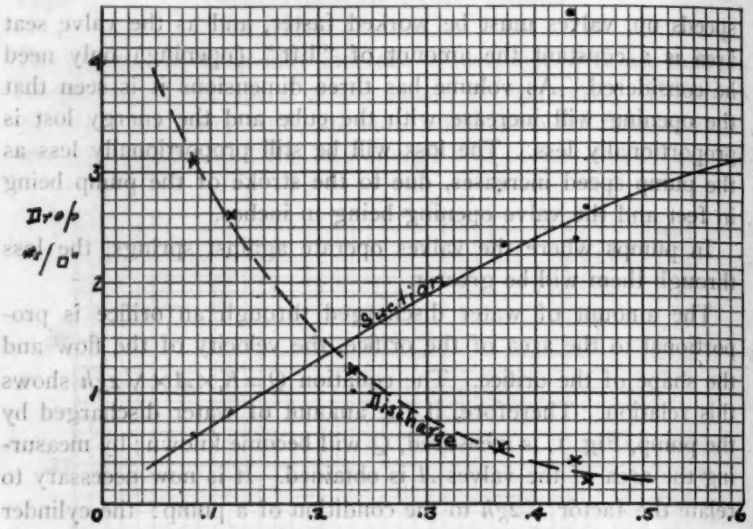

FIG. 5.—Piston Speed—Feet Per Sec.

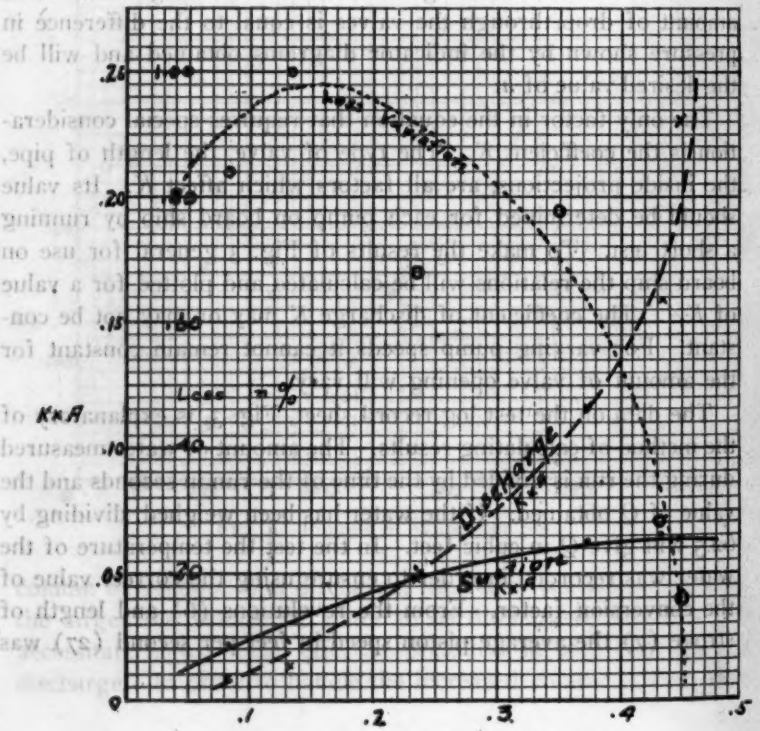

FIG. 6.—Piston Speed—Feet Per Sec.

calculated. The difference between columns (9) and (10) will give the amount of drop through the suction valves column (13) and that between columns (11) and (12) will give the drop through the discharge valves (14). Column (15) equals column (13) multiplied by 144 and divided by 62.5. Column (16) equals column (14) multiplied by 144 and divided by 62.5. The variation in the value of K is shown by plotting the value of $K \times A$ (square feet) as ordinates with pounds of water handled per second as abscissæ. This must be done for both suction and discharge. The drop through valves, varying with piston speed, is shown by plotting it against the piston speed. Assuming the area A to be one square foot the relation between K and piston speed may be shown by plotting.

A comparison of the plots of Figs. 5 and 6 shows that as the piston speed increases the value of K increases for both suction and discharge, but that the drop decreases through the discharge valves, and increases through the suction valves.

In Fig. 6, the curve showing the loss variation determines that the most economical operating speed of the pump was at full speed.

As the continual operation of any piece of machinery at high speeds—under overload, as it were—is expensive both in steam consumption and upkeep, wear and tear, it is not desirable to have the best valve operating point at speeds above the standard, normal load.

Therefore, the value of K should be made a maximum at the normal pump speed and this may be obtained by tight valves, proper type of valve, smoothing projections inside the piping and valves, and by a study of the piping. A gasket, for instance, if only partly trimmed inside will cause excessive suction losses.

Knowing, then, that K is at its maximum at normal loads, it is a simple matter to order the speeds at which an additional pump will be started to share the load. The efficient operation of the pump will save many a bucket of coal.

calculated. The difference between columns (9) and (10) will give the amount of drop through the suction valves column (13) and that between columns (11) and (12) will give the drop through the discharge valves (14). Column (15) equals column (13) multiplied by 144 and divided by 62.5. Column (16) equals column (14) multiplied by 144 and divided by 62.5. The variation in the value of K is shown by plotting the value of K × 1 (square feet) as ordinates with pounds of water handled per second as abscissæ. This must be done for both suction and discharge. The drop through valves, varying with piston speed, is shown by plotting it against the piston speed. Assuming the area 1 to be one square foot the relation between K and piston speed may be shown by plotting.

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FIG. 6.—Piston Speed—Feet Per

DISCUSSION

The Battle Cruiser

(See Page 719, Whole No. 195)

Captain T. L. Johnson, U. S. Navy.—This article preaches temperance. Commander Eggert shows clearly that no one of either the offensive or defensive characteristics of a battleship can be developed abnormally. Too much speed means too little battery, armor, fuel capacity—one, or all, of the equally essential qualities must suffer. On the other hand, a battleship, so named because it can give battle, is our embodiment of what we consider those qualities which will enable her to face any enemy. She must be able both to give and receive lusty blows, but in the fight she must give more than she receives, and like any fighter, be it an army or a prize-fighter, she must possess the stamina in the form of protection which enables her to be in condition to deliver the knock-out blow to the weakened opponent. Foot work, alone, never wins a fight. It is most often used to keep out of reach of the opponent. Let us build battleships which show normal development over preceding types and not go in for a new style just because some other nation has been pleased to do so. We can build battle cruisers to fight battle cruisers and so far we have built battleships which need never hesitate to meet an equal number of contemporaneous battleships of any enemy.

The writer does not always appear consistent, for he first casts doubts on the efficacy of the three-gun installation and later advocates four guns in a turret. Likewise he warns of the necessity for preparing to fight at 5000 yards range, and then says dispense with all torpedoes. Torpedoes at 5000 yards ought to be right effective and it is not believed any admiral would regret having them available to use against the enemy's column at that range—no, nor at 10,000 yards, either.

Then again, passive defence against torpedo attack does not appear justified on the ground that the torpedo defense battery takes so many men. In action we do not want to use the main battery against attacking destroyers, neither is there any use in letting them attack unmolested nor escape for the lack of an efficient torpedo defense battery.

The argument in favor of abandoning the vertical echelon of turrets on battleships is logical. If the ships are not built to chase or run away why arrange the guns for either? This arrangement of guns should accompany high speed, but the advantage gained in ahead and astern fire should not be abandoned unless it can be clearly shown that the weight gained applied elsewhere more than compensates for the loss of the gun fire. The reduced height of No. 2 and No. 3 turrets should add materially to the protection and the steadiness of the gun platform.

It is hoped that new methods of gun construction will so add to the battery power in the form of higher velocities that it will be a long time before the 16-inch gun must be supplanted by the 18-inch.

To revert to the question of speed, why is it we want none of the captured German ships? Because they have obtained speed at the expense of armor, battery, and steaming radius. If we now begin building 28-knot battleships, what are we to do with all our 21-knot vessels? Ten years hence they will nearly all be good ships and in case of war will be used. Let us continue as we have begun—build battle cruisers, scouts and destroyers for speed, but battleships, as Commander Eggert says, for the stand up and knock down fight.

U. S. NAVAL INSTITUTE

SECRETARY'S NOTES

Change in Board of Control

Captains W. H. Standley and J. G. Church, U. S. Navy, tendered their resignations as members of the Board of Control upon being detached from duty at the Naval Academy, and their resignations were accepted by the Board with regret on June 10, 1919. Captain W. T. Cluverius, U. S. Navy, was elected a member of the Board of Control.

Membership

Life, regular and associate membership, 5787.
New members 21: Resignations 10.
Deaths:
Lieutenant G. C. Hill, U. S. N.
Lieutenant J. R. Cruse, U. S. N.
Mr. R. L. Bacon.

Dues

The annual dues ($2.50) for the year 1919 are now payable.

Regular and associate members of the U. S. Naval Institute are subject to the payment of the annual dues until the date of the receipt of their resignation.

Address of Members

All members are urged to keep the Secretary and Treasurer informed of the address to which PROCEEDINGS *are to be sent, and thus insure their receipt.*

Members and subscribers are urged to notify the Secretary and Treasurer promptly of the non-receipt of PROCEEDINGS, in order that tracers may be started. The issue is completed by the 10th of each month.

Book Department

The Institute Book Department will supply any obtainable book, of any kind, at retail price, postage prepaid. The trouble saved the purchaser through having one source of supply for all books, should be considered. The cost will not be greater and sometimes less than when obtained from dealers.

Reprints of Articles

The attention of authors of articles is called to the fact that the cost to them of reprints other than the usual number furnished, can be greatly reduced if the reprints are struck off while the article is in press. They are requested to notify the Secretary and Treasurer of the number of reprints desired when the article is submitted. Twenty copies of reprints are furnished authors free of charge.

Illustrations

Authors of articles submitted are urged to furnish with their manuscript any illustrations they may have in their possession for such articles. The Institute will gladly co-operate in obtaining such illustrations as may be suggested by authors.

Original photographs of objects and events which may be of interest to our readers are also desired, and members who have opportunities to obtain such photographs are requested to secure them for the Institute.

Notice

Whole Nos. 6, 7, 10, 13, 14, 15, 17, 145, 146, 147, 149, 155, 166 and 179 of the PROCEEDINGS are exhausted; there are so many calls for single copies of these numbers that the Institute offers to pay for copies thereof returned in good condition at the rate of 50 cents per copy.

ANNAPOLIS, MD., JUNE 15, 1919.

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PROFESSIONAL NOTES

PREPARED BY

COMMANDER S. A. TAFFINDER, U. S. Navy

GENERAL ARRANGEMENT

VESSELS BUILDING.
NAVAL POLICY.
MATÉRIEL.
PERSONNEL.
OPERATION
MERCHANT MARINE.
France 1245
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FRANCE

AMERICAN-BUILT LAFAYETTE WIRELESS STATION IN FRANCE.—The sale of the great Lafayette wireless station at Bordeaux to the French Government at a price of approximately $4,000,000, and many hitherto unpublished facts of American naval activities in the war, were announced recently by Assistant Secretary Roosevelt. "The great Lafayette radio station near Bordeaux was intended to insure communication between Washington and the army and navy, in case the cable system was put out of commission or interfered with by German submarines," Mr. Roosevelt said. "It has eight towers and could communicate with the United States day or night. It was built by the navy. I arranged with the French Government that we shall complete the station, which is two-thirds finished, and they will then take it over at what it costs us, about 22,000,000 francs."—*Scientific American*, 5/24.

LOSS OF SUBMARINES.—Severe weather caused havoc to the eight ex-German submarines which were being towed from Harwich to France, seven of them being lost in various ways. Two parted their tow near Beachy Head, one driving ashore and the other having to be sunk by the destroyer *Francis Garnier*. These boats were part of a group of 32 which have been allotted to France.—*London Army and Navy Gazette*, 5/3.

FRENCH NAME DESTROYER FOR QUENTIN ROOSEVELT.—The only French war craft named after a citizen other than France, is the torpedo-boat destroyer *Quentin Roosevelt*, named recently as a mark of respect to the late ex-president and his son. The destroyer is the former Russian *Buiki*, which has been taken over by French naval authorities and renamed. She was rechristened last September. The *Quentin Roosevelt* was turned over by the Russians to the French because their navy was at that time short of men and they were unable to man her.—*Naval Monthly*, June.

SCHNEIDER MARINE TYPE DIESEL ENGINE.—The most recent design of naval Diesel engine produced by Schneider et Cie, France, has an output of over 2000 i. h. p. from eight cylinders, and is giving good service in the French Navy. Details of the design are quoted from *Motorship*.

The official rating of this new engine is 1450 b. h. p., at 330 r. p. m. from eight single-acting cylinders, each 410 mm. bore (16.1417 in.) by 450 mm. (17.7165 in.). The length of the engine over-all is about 30 ft., its height from bottom of bed-plate to top of valves between 9 and 10 ft., and its width equally moderate, being about 4 ft.

The engine is of the valve-in-head scavenging two-cycle type, with trunk pistons. These pistons are made in two parts, the upper part being of steel, and is oil-cooled through telescopic tubes, these having knuckled joints. At the forward end of the engine are three combined scavenging-pumps and air-compressors, and these are driven directly by the crankshaft. Between the forward cylinder and the air-pumps is arranged the vertical shaft that drives the cam-shaft and the governor. There are four scavenging-valves per cylinder.

The engine has been made direct-reversible with the idea that a submarine when carrying out necessary maneuvers can go alongside the dock, etc., without utilizing the electric motors. But, of course, with a Diesel-electric driven cargo ship the engines could be reduced in first cost by dispensing with the direct-reversing astern motion.—*Gas and Oil Power*, 4/3.

GREAT BRITAIN

THE RENOVATION OF THE NAVY.—That the close of hostilities would witness a drastic weeding-out of inferior material was foreseen by all who are conversant with naval affairs, but it is doubtful whether many were prepared for such a comprehensive clearance as the Admiralty has announced. Upwards of 170 vessels, condemned as no longer effective, will be put up for sale as soon as they have been stripped of their guns and movable equipment. As a study of the list reveals, the effect will be to place the British Navy on a purely dreadnought footing so far as its capital units are concerned. Since the original dreadnought was laid down in 1905, it has taken only 14 years to complete a revolution quite as epoch-making as was the transition from wooden three-deckers to ironclads in the middle of last century. Very early in the war it was realized that against ships of the all-big-gun type the best pre-dreadnoughts were worse than useless, being mere death-traps for brave men. For a time our margin over the enemy was not large enough to allow us to depend on dreadnoughts alone, but as new ships passed into service the pre-dreadnoughts were detached from the Grand Fleet and employed on subsidiary operations. Their weakness lay in the low power of their armament and in their vulnerability to gun-fire and underwater attack. They added little or nothing to the real strength of the navy, and no useful purpose would have been served by keeping them on the active list. Hence the admiralty's decision to repeat the "scrapping" operation which Lord Fisher initiated when he became First Sea Lord in 1904.

Practically every battleship class anterior to the dreadnought is represented in the list, the only exceptions being the "semi-dreadnoughts" *Lord Nelson* and *Agamemnon*, which are to be retained in service as part of the reserve fleet. Of the eight ships of the *King Edward* class, two were lost in the war; the *Africa*, *Dominion*, and *Hindustan* are to be disposed of, and the remaining three are now employed as depôt ships. When completed in 1905-06 these vessels were considered almost the last word in battleship design, and together they formed the finest homogeneous squadron in the world. They were the last ships to be designed by the late Sir William White. Another noteworthy class disappears completely with the sale of the *Albemarle*, *Duncan*, and *Exmouth*. Originally there were six of these ships, comprising the *Admiral* class, but the *Montagu* was wrecked

in 1906, and the *Cornwallis* and *Russell* were sunk in the war. Having an extra knot of speed and thinner armor than contemporary battleships, they have some claim to be regarded as forerunners of the battle cruiser. Further down the list are ships of the *Queen, Formidable, Canopus,* and *Majestic* classes, all famous types in their day. Of the *Majestic* it may be said that she set the fashion in international battleship design for 10 years. The *Redoubtable—ex-Revenge*—sole survivor of the old *Royal Sovereign* class, is now marked down for sale after a varied and useful career which began in 1892. She was the only representative of her class to take an active part in the war, being attached to the "scratch" squadron which bombarded the Belgian coast in 1914. Our armored cruisers suffered heavily during the war, and the fighting value of those that survive is small, but as they are useful ships for training and other peace duties, the majority of them are to be retained. The most modern cruiser on the sale list is the *Duke of Edinburgh*, completed in 1906. She was never a successful ship, her freeboard being so low that the 6-inch guns on the main deck could not be fought in heavy weather, and her speed of 22.8 knots was quite inadequate. Her Thames-built sister ship, *Black Prince*, was sunk at Jutland, together with the *Defence* and the *Warrior*. It is now generally admitted that the construction of these large cruisers, which were deficient in speed, protection, and gun power, was a costly mistake; yet the design of the *Effingham* class, now building, indicates a reversion to this dubious type. The *Effingham* and her sisters are of 9800 tons, and are expected to attain 30 knots. The armament consists of seven 7.5-inch guns, and, as they are coal-burning ships, the complement will be very large. It is certain, therefore, that they will be expensive to maintain in commission. The armor protection—as noted in Sir E. Tennyson d'Eyncourt's recent paper—is so meagre as to be practically non-existent, and the ships will thus be unable to withstand heavy punishment. On the whole the *Effingham* does not appeal to us as a type which it is desirable to multiply, even if it is deemed expedient to finish the first four, only one of which, we understand, is nearing completion. The older armored cruisers, viz., the *Drake* and *Cressy* classes, are to go, together with most of the protected cruisers launched more than 15 years ago. In the ordinary course of events the majority of these vessels would have been scrapped before now, but during the war they proved extremely useful for patrol and convoy work. Now that the emergency is over we can afford to dispense with them, more especially as we are well provided with modern light cruisers, of which we possess about 70, with speeds of 25 knots and over, besides several others under construction. In no category is the process of renovation to be more drastic than in that of destroyers. Over 100 of these vessels are to be withdrawn from the active list, and, generally speaking, all boats above 10 years of age are to be disposed of. They range from the earliest "30-knotters" to the comparatively modern *Tribal* class, built in 1906-1910. It goes without saying that after the tremendous strain of four and one-half years of war service most of our older destroyers would require a thorough refit—including new boilers, and in some cases new machinery—if they were to be of any further use, but it is equally clear that they are not worth the heavy outlay their renovation would involve. Thanks to our huge war programmes, we have an abundance of modern destroyers, so that the bulk of our older material can be sacrificed without a qualm. It is further proposed to get rid of all the torpedo boats, with the exception of the 30 odd oil-fired turbine boats built as "coastal destroyers" in 1906-1909, and 21 are to be sold immediately. Among the submarines ear-marked for the ship-breaker are most of those composing the *B* and *C* classes, which have ceased to be effective. It is interesting to note that several of the *B* class were converted into surface patrol craft during the war, their electric motors being removed.

From the foregoing account it will be seen that every class in the navy, excepting dreadnoughts and battle cruisers, is affected by the "combing-out"

policy which the Admiralty has decided to apply with such vigor. The result will be to disburden the establishment of a great mass of material the retention of which, while it would contribute nothing to the real fighting strength of the navy, would represent a heavy charge on the national revenue. To the average layman a warship is a warship whatever its age or condition, and it is possible that the public may suspect the naval authorities of going too far in their zeal for economy. For that reason it is desirable to emphasize the fact that few, if any, of the vessels now on the sale list could be usefully employed even if hostilities broke out afresh in the near future. There is no question of weakening the navy. On the contrary, the navy will be all the stronger when it has been disencumbered of so many third-rate ships that absorb men, money, and labor out of all proportion to their fighting value.—*The Engineer*, 5/16.

MORE LIGHT ON JUTLAND.—A review of Lord Jellicoe's book, *The Grand Fleet*, by Vice-Admiral Paul Behncke, is chiefly interesting for the remarks that officer makes upon the Jutland Battle. He was present at the battle as Commander of the Third Squadron of the German Fleet, with his flag in the *König*, the most modern battleship on the enemy's side, and the leader of the German battle line. It is, therefore, an opinion based on personal experience when he states that the performance of the British ships on the day of the battle was admirable. He goes on to speak of the handling of the fleet at night as faulty, "being far below the high mark made by the Grand Fleet in the day-time." He has this much of justification for his view, that the German ships were able to escape during the night and seek safety in their ports. When, however, he asserts that owing to faulty disposition the British Admiral was only able to reassemble his force on the evening of the following day, he is quite at variance with the facts, for at 4.10 a. m. that morning the Battle Fleet was formed into divisions in line ahead, at 5.15 a. m. the Battle Cruiser Fleet rejoined in accordance with orders and it was not until 7.15 a. m. that the course, was altered to north, and at noon that the decision was arrived at for the whole force to return to its home ports. The further remark of Admiral Behncke that at daybreak the German High Seas Fleet was collected ready to resume the fight is equally devoid of truth.

This Paul Behncke is presumably the officer who, as a captain at the beginning of the war, described himself in the German naval communications as Departmental Chief of the Naval Headquarters Staff. He may have been, and apparently was, acting as the mouthpiece of von Tirpitz, and his immediate superior seems to have been Vice-Admiral H. von Pohl, who also signed some of the official *communiqués*, particularly that which notified the first submarine blockade. But it was Behncke's business to put out the fabrications intended to mislead neutrals, and to impugn the honesty and trustworthiness of the British official communications. He it was who endeavored to excuse and extenuate the bomb-dropping of the German airships in January, 1915, on Yarmouth, Cromer, Sheringham, King's Lynn, and other places—although this was among the less flagrant of his efforts at misrepresentation. The most notorious was his version of the sinking of the *Lusitania*, in which he suggested that the speedy destruction of the ship must be attributed to the large quantities of ammunition on board her. If, as was probably the case, he had a hand in the semi-official statements which were put about in Germany, he was also responsible for the allegation that the *Lusitania* was practically an auxiliary cruiser, and that it was necessary to torpedo her without warning, otherwise she would have sunk the submarine. If the assumption is correct, that the Captain Paul Behncke of the Admiralty Staff is the Vice-Admiral Paul Behncke who now reviews Lord Jellicoe's book, he probably went to the High Seas Fleet when von Pohl succeeded von Ingenohl, and the Grand Admiral fell into disgrace. This would explain why he seeks to find excuses

for the policy of von Tirpitz and the action of the German Naval Staff, with which he was so intimately connected.

Fortunately, no one need rely upon German versions of the warfare in the North Sea, or upon the jaundiced views of a defeated enemy. This week there has been published a book, the first of its kind, which, without flattery, may be said to be the complement of Lord Jellicoe's volume. It contains the impressions of a naval lieutenant who served in the North Sea during the four years of the war, for the greater part of the time in the *Southampton*, one of the hard-worked light-cruiser class. Apart from the most interesting description which he gives of the ordinary routine work of the cruisers in all weathers at sea and in harbor, the author's personal records of what happened within his own knowledge at Jutland sheds new light upon several important phases of that battle. He prefaces his chapters on this subject by saying:

"I was by the chance of war placed in certain positions, at certain times, in such manner that in looking back on the action I do not believe that a single observer could have seen more, except from an aeroplane. Most of the time I was engaged in taking notes, and it is of what I saw that I propose to write. It may thus be accepted that, unless otherwise stated, the incidents described are facts for which I am prepared to vouch to the extent of my belief in my own eyesight."

The *Southampton*, it will be remembered, was flying the broad pennant of Commodore W. E. Goodenough, commanding the Second Light Cruiser Squadron. This squadron was scouting on the southern end of the screen before the Battle Cruiser Fleet under Sir David Beatty. The author describes the sighting of the enemy, the opening of the action, and how he witnessed the destruction of the *Indefatigable* and the *Queen Mary*. Later on, it was from his ship that the High Seas Battle Fleet was first sighted, and the *Southampton* got near enough for the author to count 16 or 17 battleships, with the four *Königs* in the van and the six older pre-dreadnoughts in the rear. He has an interesting reference to the clever manner in which the navigator of the ship evaded the shells from the enemy battleships by zigzagging the *Southampton* according to where he estimated the next salvo would fall. He witnessed the destruction of the *Defence*, the amazing career of the *Warspite*, the deployment of the Grand Fleet, and the manner in which the Germans managed to get away as soon as they realized the peril of their position.

It was in the night action that the most trying ordeal of the *Southampton* occurred. A vivid picture is drawn of the nerve-racking experience which this proved to be after officers and men had already endured nearly nine hours of battle. Out of the darkness five ships suddenly appeared, and from their faint silhouettes it was impossible to discover more than the fact that they were light cruisers.

"We began to challenge; the Germans switched on colored lights on their fore yardarms. A second later, a solitary gun crashed forth from the *Dublin*, which was next astern of us. Simultaneously, I saw the shell hit a ship just above the water line, and about 800 yards away. As I caught a night mare glimpse of her interior, which has remained photographed on my mind to this day, I said to myself: 'My G——, they are alongside us!'"

The action which ensued lasted 3½ minutes. The four leading German ships concentrated their lights and guns on the *Southampton*. In those 3½ minutes, she had 89 casualties, and 75 per cent of the personnel on the upper deck were killed or wounded. The range was amazingly close—no two groups of such ships have ever fought so close in the history of this war. After describing how the guns in his control aft were put out of action because everybody was killed except the sergeant major and himself, and how with the assistance of a steward he managed to put out a fire which had ignited half a dozen rounds of cordite, he says:

"Then it became lighter than the day. I looked forward. Two pillars of white flame rose splendidly aloft. One roared up the foremast, the other reached above the tops of the second and third funnels. This, then, was the end! The heat warmed the cheek. It was bad luck, just after we had got the small fire aft extinguished. But there could be no doubt; the central ammunition hoist was between those two funnels. What was it going to feel like to blow up? . . . . Might as well take one's great coat off, just in case one fetched up in the water. I took it off. . . . . Fascinating sight, those two pillars of white flame. By Heaven! the center one had turned red, it wavered, it decreased in height, it grew again, but the spell was broken and I rushed to the ladder which led from the waist to the boat-deck in order to get up to the fire and assist. I ran a few steps and tripped up over a heap of bodies. I got up, tried not to tread on soft things, and arrived on the boat deck. The firing had ceased, the commander and h. b. were at the central fire. It suddenly went out, so did the foremost one. Everything was pitch black. Where were the Germans? Nothing but groans from dark corners. Though I did not know it at the time, the Germans had fled. They fled because A., our torpedo lieutenant, had fired a 21-inch torpedo. At 41 knots, the torpedo had shot across and striking the *Frauenlob* had blown her in half. Out of 300 Huns in her, seven survived. I have their account of the action before me. They say, 'the leading ship of the British line burst into flame and blew up. . . . . Then we were torpedoed.' They were wrong—their friends sheered off just a few seconds two soon."—*Army and Navy Gazette*, 5/3.

FEATURES OF THE "REPULSE."—The main armament of the *Repulse* consists of six 15-inch guns, of the mark first adopted for the *Queen Elizabeth* class, and described by Mr. Winston Churchill as the best gun we have ever produced. In view of Sir E. Tennyson d'Eyncourt's paper, and of the official data contained therein, it is now permissible to speak of this weapon rather more freely than was desirable while the war conitnued. The gun has great longitudinal strength, and has been quite free from the defects which revealed themselves in the case of the very long 12-inch model that ante-dated the 13.5-inch and 15-inch. The last-named has the relatively modest length of 42 calibers, and its shell weighs 1920 pounds. Thus, the total weight of metal fired at each discharge from the six guns of the *Repulse* is 11,520 pounds; as against the 11,200 pounds fired from the eight 13.5-inch guns of the *Tiger*. But the novel feature of the *Repulse's* armament is the system of mounting the 4-inch quick-firers, of which she carries 17. Fifteen of these guns are mounted on triple carriages, an arrangement permitting concentration of fire which is very useful against attacking torpedo craft. The triple mounts are quite simple in design. The three guns, of course, are trained as one, but in all the other motions each weapon is independent of the others, and is loaded and elevated as a unit. The crew of each triple 4-inch mounting numbers 21. Although the system had been subject to trial before being installed in the *Repulse* and several other ships, it is still more or less in the experimental stage, and has not yet found universal approval. The prevailing opinion seems to be that concentration of fire is purchased at too heavy a sacrifice of accuracy and rapid working.—*The Engineer*, 5/23.

PROGRESS IN AERONAUTICS.—The Aeronautical Commission of the Peace Conference is well advanced by now with the ground-work of the International Convention regarding aircraft, and with the framing of the regulations which are to be contained in annexes to the Convention concerning the marking of aircraft, certificates of air-worthiness, log-books, rules as to signals, rules of the air and regulations for air-traffic on aerodromes and on the vicinity of the latter.

With regard to the marking of aircraft a system of marking by capital letters has been recommended. The first letter will represent the national

mark of the country from which an aircraft hails. This will be followed by a group of four capital letters (pronounceable as a syllable, if possible), containing at least one vowel. A complete group of five letters is to be used as a call sign in making or receiving signals by wireless. In the case of aeroplanes, the marks are to be painted once on the lower surface of the lower main planes, and once on the upper surface of the top main planes, and also along each side of the fuselage. In the case of airships and balloons the marks are to be painted on both sides. The height of the marks must be equal to four-fifths of the width of the wing in the case of aeroplanes, and in the case of airships at least one-twelfth of the circumference at the maximum diameter, but they need not exceed 2½ meters in height. They are to be painted, or affixed, in black on a white ground.

The main conditions governing certificates of air-worthiness include approval of design, flying-trials of the first type, approval of workmanship and materials, and equipment with suitable instruments.

The recommendations as to log-books contemplate four different kinds—journey log, aircraft log, engine log, and signal log. The journey log is to be kept up by all aircraft in the case of international flights, the other three are only obligatory in the case of commercial aircraft and are to contain entries of a technical character, the engine and aircraft logs including a record of the life of the engine and aircraft.

The rules as to lights are modelled to a certain extent upon similar rules in use at sea, and there are detailed rules as to aircraft wishing to land at night, and in the case of aircraft in distress. These include the use of Very lights and certain visual or wireless signals.

The rules of the air follow the rules of the sea in many respects, especially in the case of the passing rule, when two aircraft are meeting. In that case each must alter its course to starboard.

Regulations for air-traffic on or in the vicinity of aerodromes contemplate the use of colored flags, indicating whether the circuit which an aircraft may find it necessary to make, when about to land, should be clockwise or anti-clockwise. There is also a very essential provision for dividing every aerodrome into three zones, when landing upwind. The right-hand zone is to be the taking-off zone, and the left-hand the landing zone, and between the two there is to be a neutral zone, into which, after its landing-run, an aeroplane will immediately taxi.

In the general provisions at the end of this code there is a rule, providing for every aircraft which maneuvers under its own power on the water, conforming to the regulations for preventing collisons at sea.—*United Service Magazine*, May.

The Admiralty announces that it has been decided to place a memorial tablet on board each merchant vessel that acted as decoy ship during the war, the tablet to be inscribed with certain details of service, together with the names of commander and members of the crew who received decorations.—*London Army and Navy Gazette*, 5/24.

VICKERS' VIMY-ROLLS AEROPLANE.—The overall length of the machine is 42 feet 8 inches, and the total height is 15 feet 3 inches. The span of the main planes, both of which are equal, is 67 feet, and the chord is 10 feet 6 inches. This gives a wing area, allowing for the part of the bottom plane cut away for the fuselage, of 1330 square feet. The engines give the machine a speed of 100 m. p. h. when fully loaded with bombs at a height of 10,000 feet, which height is reached in 50 minutes. Without bombs the same altitude is reached in 23 minutes, and the speed in this condition is 103 m. p. h. The machine is capable of flying for 11 hours at full speed at a height of 10,000 feet.

To the overall dimensions of the main planes already given we may add that the gap between them is 10 feet.

To equip the machine for the Atlantic flight it was, of course, necessary to provide greatly increased capacity for the storage of petrol. The bomb racks were therefore removed, and the space occupied by these, and also by the gunner's cockpit, was used for the accommodation of the extra tanks. The capacity of the petrol tanks has now been increased to 865 gallons, which, it is calculated, will give the machine a range of 2440 miles at a cruising speed of about 90 m. p. h. The maximum speed, however, is still over 100 m. p. h., and the machine is capable of flying at about 70 m. p. h., with one engine out of action.—*Engineering*, 5/9.

HANDLEY-PAGE BIPLANE.—The Handley-Page biplane has a wingspread of 127 feet, the chord of which is the distance between the upper and lower planes 15 feet 8 inches, and a plane surface of 3040 feet, with a lifting capacity of 9.08 pounds per square foot. She is fitted with four Rolls-Royce Eagle engines, giving a total rated horsepower of 1500 and actually developing well in excess of this rating.

Some idea of the power of the Handley-Page plane, originally built to bomb Berlin, can be gained from the following facts: When first built the machine weighed, unloaded, 14,000 pounds. The gasoline capacity was 1190 gallons, weighing 7140 pounds. The wireless apparatus was weighed at 200 pounds, and there was also provision for 6640 pounds of bombs, twelve machine guns weighing 757 pounds, and a crew of seven men weighing 1206 pounds, making a total load-carrying capacity of 29,943 pounds. Thus loaded the planes had a cruising speed of ninety miles an hour. By eliminating the bombs, machine guns and other paraphernalia, it has been possible to increase the fuel capacity to 2366 gallons as compared with the 865 gallons of the Vimy-Vickers, the 330 gallons carried by the Sopwith and the 370 of the Martinsyde. With this fuel load which can be carried on the journey over the ocean, the engines will consume an average of 108 gallons of gas per hour, giving an approximate cruising radius of twenty-two hours of continuous flight without making any wind allowance.—*N. Y. Times*, 5/25.

NEW BRITISH AIRSHIPS.—It is well known that at least four airships larger than the *R-33* and *R-34* are at present under construction in this country for the British Admiralty. These new vessels, it is understood, are being built by Messrs. Beardmore, Armstrong-Whitworth, and Short Brothers, and are reported to be designed to have a lifting capacity of 70 tons. They will have a length of 700 feet, contain 2½ million cubic feet of gas, and cost about a million pounds apiece. Their speed will be in the neighborhood, it is believed, of 80 miles an hour. Two of the vessels will be fitted, we learn authoritatively, with four 350-horsepower "Cossack" type Sunbeam-Coatalen engines; the other two will have four "Cossack" engines and, in addition, two 250-horsepower "Maori" type engines, giving a total of 1900 horsepower. These vessels, it is expected, will be completed round about the end of the year.—*The Engineer*, 5/16.

The British Daily Weather Report, issued by the Meteorological Office in London, has recently undergone a notable expansion, reflecting the great increase in the work carried on by England's "Clerk of the Weather" in response to the varied demands that arose during the war. Since April 1 the report has been issued in three separate sections; viz., a British Section, an International Section and an Upper Air Supplement. All three sections contain weather maps. In the Upper Air Supplement there are maps of the British Isles showing the winds at various levels from the surface up to 15,000 feet, for afternoon, evening and morning. This is primarily for the information of aeronauts, but will prove of great interest to all meteorologists.—*Scientific American*, 6/7.

UNITED STATES

NAVY DEPARTMENT—BUREAU OF CONSTRUCTION AND REPAIR

VESSELS UNDER CONSTRUCTION, UNITED STATES NAVY—DEGREE OF COMPLETION, MAY 31, 1919

Type, number and name	Contractor	Per cent of completion				Contract date of completion
		June 1, 1919		May 1, 1919		
		Total	On ship	Total	On ship	
Battleships[1]						
43 Tennessee	New York Navy Yard	75.6	71.1	72.6	68.6	1/9/19
44 California	Mare Island Navy Yard	62.9	52.9	59.9	48.9	.....
45 Colorado	New York S. B. Co.	25.	3.8	20.4	3.4	5/17/20
46 Maryland	Newport News S. B. & D. D. Co.	48.	37.5	45.9	35.9	.....
47 Washington	New York S. B. Co.	23.2	3.2	18.5	2.8	11/17/20
48 West Virginia	Newport News S. B. & D. D. Co.	22.1	2.2	21.3	2.2	.....
49 South Dakota	New York Navy Yard	0.	0.	0.	0.	.....
50 Indiana	New York Navy Yard	0.	0.	0.	0.	.....
51 Montana	Mare Island Navy Yard	0.	0.	0.	0.	.....
52 North Carolina	Norfolk Navy Yard	0.	0.	0.	0.	.....
Battle Cruisers						
1 Lexington	Fore River S. B. Co.	....	....	....	....	.....
2 Constellation	Newport News S. B. & D. D. Co.	....	....	....	....	.....
3 Saratoga	New York S. B. Co.	....	....	....	....	.....
4 Ranger	Newport News S. B. & D. D. Co.	....	....	....	....	.....
5 Constitution	Phila. Navy Yard	....	....	....	....	.....
6	Phila. Navy Yard	....	....	....	....	.....
Scout Cruisers						
4	Todd D. D. & Const. Co.	27.3	4.7	26.2	2.9	8/1/21
5	Todd D. D. & Const. Co.	25.6	3.4	24.3	2.5	12/1/21
6	Todd D. D. & Const. Co.	21.2	1.	20.1	1.	7/1/22
7	Beth. S. B. Co. (Fore River)	0.	0.	0.	0.	8/1/21
8	Beth. S. B. Co. (Fore River)	0.	0.	0.	0.	11/1/21
9	Wm. Cramp & Sons Co.	10.	....	10.	....	.....
10	Wm. Cramp & Sons Co.	10.	....	10.	....	.....
11	Wm. Cramp & Sons Co.	1.	....	0.	....	10/1/21
12	Wm. Cramp & Sons Co.	1.	....	0.	....	1/1/22
13	Wm. Cramp & Sons Co.	1.	....	0.	....	4/1/22
Miscellaneous[2]						
Fuel Ship No. 16, Brazos	Boston Navy Yard	95.	94.5	93.1	92.6	.....
Fuel Ship No. 17, Neches	Boston Navy Yard	24.5	6.	23.8	1.5	.....
Fuel Ship No. 18, Pecos	Boston Navy Yard	.2	.2	.2	.2	.....
Gunboat No. 21 Asheville	Charleston Navy Yard	83.5	81.5	81.3	79.3	.....
Gunboat No. 22	Charleston Navy Yard	3.	2.	1.3	.3	.....
Hospital Ship No. 1	Phila. Navy Yard	31.	22.	27.4	15.8	.....
Amn. Ship No. 1, Pyro	Puget Sound Navy Yard	90.	83.	86.	78.	.....
Amn. Ship No. 2, Nitro	Puget Sound Navy Yard	46.	30.	38.	18.	.....
Rep. Ship No. 1, Medusa	Puget Sound Navy Yard	....	....	....	....	.....

[1] Battleships authorized but not under construction or contract (2) Nos. 53 and 54.

[2] Miscellaneous vessels authorized but not under construction or contract (4):
1 submarine tender No. 3.
2 destroyer tenders Nos. 3 and 4.
1 transport No. 2.

There are 12 destroyers and 10 submarines authorized but not under construction or contract.

There are 178 destroyers, 68 submarines, 11 mine sweepers, 19 sea-going tugs, 29 habor tugs, 12 oil tankers and 51 Ford eagles in various stages of completion.

NAVAL POLICY

SALE OF OBSOLETE BATTLESHIPS.—In addition to the four ancient battleships which were removed from the navy register some weeks ago—the *Indiana, Iowa, Massachusetts,* and *Oregon*—several more are destined to share the same or a similar fate in the very near future. The Navy Depart-

ment is now considering the disposition of eight battleships, all of which have been outclassed and are obsolete so far as their fighting value is concerned. These vessels are the *Kearsarge, Kentucky, Illinois, Alabama, Wisconsin, Maine, Missouri,* and *Ohio.* Some of these vessels are now engaged on duty with the midshipmen's practice cruise, and no steps will be taken towards placing them out of commission until the expiration of the summer cruise. Meanwhile the board of inspection and survery will investigate the subject and make its report as to whether any of the vessels could be retained on the navy register. These vessels were built in the period following the Spanish War. If they are placed out of commission, it is estimated that there will be released for more modern vessels approximately 10,000 enlisted men and about 400 officers.—*Army and Navy Register,* 6/7.

FILIPINOS TO MAN OWN GIFT SHIPS.—The Philippine Islands have the distinction of being the first American dependency to give to the federal government a destroyer and a submarine for the navy. In return the Navy Department has provided for the training of Filipinos as seamen, so that members of the crews, including petty officers, of the two ships will be natives of the Philippines. The destroyer *José Rizal* and the submarine *F-30,* now building at the Union Iron Works, San Francisco, are the two gifts of the Philippines. There are now in training at the Mare Island Navy Yard 97 Filipinos who will be members of the first crew of the destroyer. Others will be added until the full complements of 114 for the destroyer and 39 for the submarine are provided. Heretofore, with few exceptions, Filipinos have been enlisted in the navy only as mess attendants, but when the gift was announced an order was issued by the Navy Department to the commanding officer of every ship afloat to nominate from his crew such Filipinos as he considered capable to form the complements for the new vessels.—*Army and Navy Journal,* 5/17.

PERSONNEL

NAVY COMMISSIONED PERSONNEL.—Discussion continues in naval circles over the possibility that Congress may enact legislation for the early discharge of officers of the navy and marine corps from their temporary commissions, which would involve demotion to lower commissioned, warrant and enlisted grades of those belonging to the permanent personnel and the entire separation from the service of those drawn from the naval reserve force, national naval volunteers, and civil life. In these columns last week it was stated that it was not seen "how the service can get along with only the permanent allowances of officers, which is just sufficient for the permanent force of 137,000 men in the navy and 14,700 in the marine corps." It was not intended to indicate that those branches of the naval service were in possession at present of the full allowance of permanent officers for that number of enlisted personnel, for, as a matter of fact, the actual number of permanent officers is far short of that. In the navy the allowance of line officers is 4 per cent of the enlisted force, the permanent strength of which is 137,485 men. Thus there should be 5499 line officers, whereas there are actually in the service, including approximately 225 midshipmen to be appointed ensigns this month, only 2925 line officers, leaving a deficit of 574, which is made up by temporary appointees. With the permanent navy temporarily increased by executive order, in accordance with the law, by 50,000 men, or to 187,485, there should be 7499 line officers, but there are only about 6744 such officers, this number being made up of the 2925 permanent officers and 3819 temporary ones, and there is an actual deficit of 755 officers. Of the temporary officers, about 2088 came from the naval reserve force and the national naval volunteers, and about 1731 that hold temporary commissions, lieutenants, junior lieutenants and ensigns from their permanent warrant and enlisted grades in the regular navy. While the demotion of officers to lower commissioned grades will be sufficiently demoralizing,

the consequences to the almost 2000 officers, most of whom have proved their qualifications as commissioned officers, that will have to go back to warrant and enlisted ratings will be far more discouraging and unjust, and it is hoped in the service that, if Congress does not do anything for the permanent commissioned officers, it will enact legislation that will permit the other class of temporary officers to obtain permanent commissions under proper restrictions. While officers have no hope of having the pay-tables revised upwardly this year, nevertheless they feel that it should be done. Such a revision undoubtedly would be made to include pay of army officers, and, with the army at its present size, Congress would consider the cost prohibitive. Accordingly it is likely that nothing will be done toward readjusting service pay until the services get back to the strength ultimately to be fixed by Congress as permanent. Secretary Daniels has refused to approve increase of pay on the ground that a large proportion of the commissioned personnel is receiving higher pay by reason of promotion. Of course, this argument is fallacious and does not apply if officers are forthwith to be demoted, some of them by two or three grades.—*Army and Navy Register*, 6/7.

ADMIRAL SIMS OPENS WAR COLLEGE.—*Thirty Officers in New Class.*—The Naval War College was reopened informally on June 2, the occasion being marked by an address on the basic principles of the course of instruction at the college by Rear Admiral William S. Sims, U. S. N., president of the college, who resumed his duties that were interrupted by the war, as were the classes. Addressing the 30 officers comprising the new class, Admiral Sims said in part:

"There has been wasted during this war a great deal of effort, much valuable material, and even many valuable lives because of the lack of training necessary to reach logical decisions based upon the well-known immutable principles of war. The constant prayer of those who bear great responsibility in time of war is that they may be spared the results of the decisions of the so-called practical officers who are ignorant of the art of war and who have not been trained to think straight—that is, who have not been trained to make a logical estimate of a situation.

"It should be clearly understood that the college does not propose to establish a code by which naval warfare can be conducted. It does not propose rules for meeting various situations. This would be wholly impossible because of the infinite variety in the character of the conditions and situations. Each problem must be dealt with on its merits, in accordance with certain general principles which it is the object of the college to develop and to teach. That is, the college aims to supply principles, not rules, and, by training, develop the habit of applying these principles logically, correctly and rapidly to each situation that may arise. The college does not claim to show what should be done in particular cases, but hopes that the college training in the appplication of the principles of warfare to problems based upon modern conditions will enable you to reach acceptable solutions in any case that may arise.

"As there sometimes arises the impression that the college is, or should be, the plan-making branch of the navy, it may be well to repeat the explanation of its proper function that has been given by former presidents. It is true that the college could supply plans as required if it were provided with a special staff for this purpose many times larger than its present staff, but as the data essential for this work are necessarily continuously accumulating in the various branches of the Navy Department, it is manifest that such a planning section should not be located here."

Limitations of the College.—"It would be wholly impossible for the teaching staff to undertake plan-making in addition to its own work. It is for this reason that the college does not assume, and cannot undertake, any administrative functions. Administration involves action, and the essential function of the college is not action but training for action. While we

cannot supply strategic plans required by the Navy Department we hope to supply officers who can formulate such plans. Similarly, we cannot supply tactical battle plans to fit all conditions that may arise in the fleet; but if the college course proves successful it will supply commanders-in-chief and fleet staff officers competent to prepare and carry out such plans. If the college should be required to do planning work it would cease to be a teaching institution and become a part of the general staff, with the duty of supplying plans instead of officers trained to prepare plans.

"Some officers have admirable knowledge and experience, but fail in the quality of military character. They are honest, loyal, zealous and devoted. They know the principles of warfare, but do not always exercise the will and self-control to apply them. They understand the principle that in extensive organizations work should be divided according to specialties and the head of each section given full responsibility and authority, but they do not apply it—hesitating to allow authority, even in minor matters, to pass out of their hands. This subject will be taken up in due course. Its importance is due to the fact, often demonstrated, and particularly so in the Great War, that not infrequently officers of quite exceptional ability, knowledge, experience and energy failed to succeed because they did not understand, or did not apply, the principles of military character."

Admiral Sims also made some references to the importance of the submarine in warfare, pointing out particularly the value of the larger underwater craft, those with a cruising radius of two or three months. For scouting purposes he considers such a craft a dangerous weapon against other types of scout vessels. He said destruction of enemy submarines in the war was most effective by Allied submarines, England especially being successful in this way.—*Army and Navy Journal*, 6/7.

NAVY POST-GRADUATE SCHOOL AT ANNAPOLIS OPENS.—Exercises were held at the U. S. Naval Academy at Annapolis, Md., on the night of June 12, marking the reopening of the Post-Graduate School of the Navy. The school is attended by twenty ordnance engineering officers and thirty officers from the Bureau of Steam Engineering. The exercises were attended by Secretary of the Navy Daniels and party, and by a large number of officers attached to the Naval Academy. In his address to the school the Secretary emphasized that the students were assigned to the school for special training as experts because there must be a few officers who will be especially designated as expert engineers throughout the entire length of their service. He added: "Due to various reasons sufficient importance is not given by the officers of the navy, as a whole, to the value of engineering duties. I think it would be well if all young officers, immediately upon completion of their course at the Naval Academy, were required to perform engineering duties in a ship for a certain continuous and definite time. It is my opinion that their experience would serve as the best foundation for all the duties which young officers would be called upon to perform in their future service. . . . It is a false theory that some men shall give themselves to problems of battle practice, others to engineering and to ordnance. The great commander is greater if he has been trained in all, for knowledge of engineer and ordnance duties is essential to the highest when in command of modern machine warfare."—*Army and Navy Journal*, 6/14.

MERCHANT MARINE

WILL BIND THE TWO AMERICAS.—Plans for the establishment of direct steamship lines connecting American Atlantic, Gulf and Pacific ports with South and Central America were laid before the Pan-American Commercial Conference here to-day by Chairman Hurley, of the Shipping Board. They call for direct lines from New York to Brazil, Argentina and Chili; from New Orleans, or Mobile to the west coast of South America, and Seattle and other Pacific ports to Western South American ports.

The line between New York and Brazil and Argentina, Mr. Hurley said, will be inaugurated on November 1, with the former German liners *Mount Vernon, Von Steuben* and *Agamemnon*, which are to be remodeled for this trade. These vessels have a speed of 23½ knots an hour and will be able to make the trip from New York to Rio de Janeiro in nine days and to Buenos Aires in fourteen days.

"Contemplated plans," said Mr. Hurley, "call for at least two lines from New York to serve the West Indian trades, one of them covering the Eastern Caribbean and the other the Western Caribbean, with canal connections at Colon. To serve the swelling commerce of the west coast a line will be maintained connecting Valparaiso and the other western ports with Mobile or New Orleans. We have to-day a passenger service from New York to Valparaiso, which is nine days shorter than existed one year ago. As soon as the army returns our American transports we will have weekly service from New York to Valparaiso on five passenger lines through the Panama Canal.

"Good liner service between Valparaiso and Seattle, with calls at all the important Pacific ports, and also between San Francisco and New York will be assured, and American lines already established in this field will be supplemented where required. Finally and most important, there will be a line from New York to the ports of Brazil and the River Plata. Modern ships of the passenger cargo type operated over these lines will connect the great centers of trade, and to them will flow commerce from many intermediate points.

"It is realized that nothing less than the best will serve to satisfy the demands of Latin-American travelers and exporters. Therefore, no effort will be spared to make these lines conform to the highest standards of modern steamship service. It is hoped to have them specially designed for the South American trade and equipped with the conveniences and luxuries which the long trips in tropical seas require. The 14 ships under consideration for these trades are of about 18,000 gross tons, with accommodations for about 300 first-class passengers.

"Before the war the best ships in direct service from the United States to the eastern ports of South America made only 15 knots, offered only fortnightly sailings and took 24 days for the trip from New York to Buenos Aires. Compare this with the service to be expected in the immediate future. Three magnificent ex-German liners, the *Mount Vernon*, the *Von Steuben* and the *Agamemnon* are to be remodeled for South American trade. These ships make 23½ knots, so that the trip from New York to Rio de Janeiro can be made in nine days and that to Argentina capital can be made in 14 days. There will thus be a saving of at least a month's time on the round trip."

Mr. Hurley told the conference that 226 ships of 863,334 dead-weight tons already had been allotted to the Latin-American trade and that others would be assigned as soon as they became available.

Enthusiastic applause greeted Mr. Hurley's announcement of improved steamship service to South America. He pointed out that the mail service between the two countries would be greatly improved. Mail between the United States and South America is now being carried in foreign vessels, but it will be transferred soon to American ships, Mr. Hurley said, and by the improved service a letter mailed in New York will reach its destination in Buenos Aires in 15 days. Within one month a reply may be received in New York.—*New York Times*, 6/5.

204 VESSELS DELIVERED THIS YEAR TO SHIPPING BOARD.—From January 1 of this year to May 7 a total of 204 steamships, with an aggregate of 781,980 gross tons were delivered to the United States Shipping Board by American yards. From January 1, 1918, to December 31, 1918, the output was 527 steamships, with an aggregate gross tonnage of 1,991,587.

April of this year was the banner month in deliveries, the total being 93 steamships of 320,280 gross tons. The previous best month was October, 1918, when 263,000 gross tons were delivered.

Deliveries for 1919 were as follows:

Type	Number	Tonnage (gross)
Steel	161	683,780
Wood	39	88,867
Composite	4	9,333

—*U. S. Bulletin*, 5/19.

DEMOUNTABLE SHIPS PROPOSED.—Seattle steamship operators and district lumber producers are watching with interest developments on the new demountable ship recently patented by a Victoria shipper, says the Seattle *Post-Intelligencer*. There is hope that the proposal will materialize, as its success will relieve those who are concerned over the scarcity of bottoms for lumber cargoes. The new plan contemplates constructing boat and cargo together and selling the entire outfit on arrival at its destination.

It is reported in shipping circles that the Furber Lumber Company of Mexico is interested in the venture and will construct a number of these vessels at an early date, with engines capable of a 7-knot speed. The engines will be sent back to the point of origin for another ship after the voyage is made. It is claimed that the new device can be constructed as cheaply as putting the lumber inside of any ordinary ship. The method of fastening the ships together will be such that after its voyage the nuts and bolts are taken off, leaving all the lumber ready for distribution.

A boat which now carries only 1,500,000 feet of fir would, under the new patent, carry 5,000,000 feet, and no provision would have to be made for the return cargo, it is claimed.

Naval Engineer J. H. Price has assumed charge of constructing the new demountable ship for a Canadian and Washington lumber company.—*Nautical Gazette*, 6/14.

NAVIGATION AND RADIO

RADIO COMMUNICATION IN ALASKA.—The army signal corps plans to use wireless in communicating with Alaska when the present cable is worn out. The cable will not last much longer, and an appropriation of $250,000 is desired to cover the establishment of six additional modern wireless stations to complete a chain of stations from Seattle to Fairbanks. There are 13 stations now in operation in Alaska for interior communication, and the returns from commercial business show they are self-supporting. The government use of the service was not counted in the financial returns, although it was 75 per cent of the total business.—*Army and Navy Register*, 6/7.

ENGINEERING

NEW DESTROYER DOES 38.38 KNOTS.—All speed records of the Rockland trial course have been broken by the new torpedo-boat destroyer *Hale*, according to an announcement by officials of the Bath Iron Works to-day. A mean speed of 37.63 knots was made during builders' preliminary trials, while the fastest mile, with wind and tide favoring the ship, was made at the rate of 38.38 knots an hour.—*N. Y. Times*, 6/8.

X-RAY EXAMINATIONS APPLIED TO THE METALLURGY OF STEEL.—The following is an abstract of a paper presented at the joint meeting of the Faraday Society and the Röntgen Society, recently held in London, by Sir Robert Hadfield, Bart., Mr. S. A. Main, B. Sc., and Mr. J. Brooksbank:

(1) The possibilities of X-ray examination in steel manufacture will be readily apparent. The means which it provides for enabling the metallurgist

to see the interior of steel castings and forgings, and thus to diagnose and localize the diseases to which steel is subject, must prove of considerable benefit.

(2) The chief difficulty hitherto has been the limited thickness of metal which could be penetrated, but considerable strides have been made within the last year or two in this direction. Thicknesses up to 4 inches are now said to have been successfully radiographed.

(3) It is obvious that to be of service it must be possible to examine articles of a practical size; otherwise the chief advantage of such a method of examination is lost—namely, its non-destructive character. A few years ago, and even now with the larger articles, it was necessary in order to examine a casting to cut out a section to obtain a radiograph, thus destroying the article for practical purposes. While this served its purpose for research examination, it still left the wider application—that is, for inspection of articles intended for service—untouched. The advantages of applying the method to the routine examination of special steel castings and forgings in the course of their manufacture, to ensure their being thoroughly sound, will be at once apparent.

(4) X-ray examination need not necessarily be confined to the steel products themselves, but also to materials used by the steel manufacturer; another application which suggests itself is the examination of welds.

(5) The question of internal defects has always been a bugbear. In the case of an habitual tendency, such as the well-known "pipe" in ingots, this usually reproduces itself under similar conditions of manufacture, and can be controlled by the cutting up and examination of an individual ingot out of a lot, this forming a criterion of the whole. Many of the defects met with are, however, of a casual nature, and the use of X-rays will help in these cases by individual examination and elimination of the defective articles.

(6) Apart from the mere detection of defects, it is a distinct advantage to have these defects visualized to the eye, and the perspective view presented by a stereoscopic radiograph carries much more information to the mind as to the nature of the defect than the alternative method of fracturing the article through the defect, which only presents a sectional view.

(7) The routine operation of X-ray examination will be much facilitated if the necessity for photographing can be avoided; that is, if articles may be examined by the use of a fluorescent screen. This would very much increase the rate of examination and, after all, in inspection work, the majority of the articles are expected to be free from defects and, therefore, no permanent record is required. In those cases where a permanent record is required, the particular articles may, of course, be put on one side for the purpose.

(8) A further point is that of expense. Present apparatus for the purpose is costly and delicate, and its operation of a rather expert nature to be applied to routine purposes.

(9) It must be borne in mind that in the present state of the science, X-ray examination does not magnify defects, so that its utility is limited to those defects which are of a size within the visibility of the naked eye. Many of the defects in steel arise from microscopic causes, and these must still rely for their elucidation on the valuable work covered by micrography.

(10) Quite apart from the question of defects in steel is the very valuable field in theoretical metallurgy, opened up by Professor W. H. Bragg and followed with great ability by Professor A. W. Hull, applied to the atomic and crystalline structure of metals. Whilst this subject is rather a matter for the research laboratory, it should eventually give positive evidence on vexed questions, concerned with the atomic structure, such, for example, as allotrophy, on which, hitherto, it has only been possible to theorize.

(11) A still further application for X-rays in metallurgy, which may perhaps be mentioned, is the analysis of steels. Chemical methods are so

well established and on the whole so satisfactory, that X-ray examination can hardly take their place. Still, the subject is one which may well be worked upon both for its own sake and the additional viewpoint which it provides as to the constitution of steels.—*Page's Engineering Weekly*, 5/10.

VALVES AND FITTINGS IN MARINE WORK.*—It has taken this world war to accelerate the adaptation to ships of much of the standard central-station apparatus. Certain factors are now at work which have considerable influence on present marine practice in valves and piping. Of these the greatest is the fabricated-shipyard. In the old-style yard, the shops would make up any or all of their fittings or valves to their special designs, each yard having its own designs which differed from those of other yards. The result of this was a constantly increasing number of special valves and types in each shipyard, with the consequent increase in cost of ship construction.

The fabricated-shipyard, however, has been forced to buy in the open market and in order to get deliveries has had to purchase standard types and sizes. This has caused engineers to study their valves and endeavor to standardize them. In one yard it was thus found possible to reduce the number of types by 20 per cent.

It is entirely practicable to use manufacturers' standard stock patterns for nearly all valves, fittings and auxiliary equipment, and this standardization, with consequent reduced costs, will be one of the deciding factors in maintaining our shipbuilding supremacy after the war. Standard valves require fewer repair parts and these are more easily procurable for renewal. Decided advantages may be gained by still further extending present standardization.

Piping.—A factor which has influenced piping practice is the availability of materials. For instance, copper piping in sizes suitable for steam mains has become so scarce that open-hearth lap-welded steel pipe is often adopted in its place. The use of copper piping has long been standard practice on shipboard. This piping has considerable flexibility and generally stands up well in marine service, but it is not well adapted to superheat conditions. Steel pipe is much cheaper than copper pipe, is more readily available, and is well adapted to any pressures and temperatures that may be encountered.

Some engineers fear that it may lack the flexibility of copper pipe, although steel piping in central stations is frequently subjected to strains from contraction and expansion as severe as one finds on board ship; furthermore it is frequently subjected to severe stresses due to unbalanced turbine rotors and other harmonic vibrations. The substitution of steel for copper piping is merely a matter of marine engineers becoming accustomed to designing and installing their steam systems in accordance with steel-pipe standards. In other words, it is dependent on their ability to break away from traditional practice.

Steel pipe, however, does not withstand corrosion as well as copper pipe. Galvanized steel pipe has been tried for this purpose. In time the galvanized material flakes off under the influence of heat and causes trouble. Repeated painting of such steel pipe seems to be the best protection.

Galvanized pipe should be used on sanitary systems and bilge and ballast piping. However, no advantage is gained by galvanizing the cast-iron fittings of these systems. It is also questionable whether fuel-oil piping in oil-burning ships needs to be galvanized at all.

The problem of caring for expansion has made many engineers prefer copper to steel in piping. In general, long-radius bends provide the best means for taking care of expansion difficulties. Space is limited in vessels,

* Presented at meeting of Baltimore Section, American Society of Mechanical Engineers.

but much may be accomplished in the way of providing such bends if a little study is given to the subject. Some have questioned the flexibility of bends of extra heavy steel pipe. The Crane Company tables indicate that there is usually ample flexibility to care for any lengths that are generally used on shipboard.

Pipe Flanges.—Expanded flanges of the Lovekin or similar types are almost universal with copper pipe. Lovekin flanges are used to some extent with steel pipe, but welded or screwed joints are more common. Land practice in piping seems to have advanced far beyond marine practice in the use of the Van Stone joint. It is said that the first installation of this type of flange on shipboard many years ago was not a success. Apparently this has condemned an excellent joint ever since. Although giving excellent service under most exacting conditions on land, it is taboo at sea. The welded type of Van Stone joint now in use in central stations has apparently never been tried out at sea.

Fittings.—With superheated steam, and in general with all steam of over 150-pound pressure, it is advisable to use cast-steel fittings on the steam lines. For pressures of 100 to 160 pounds, extra heavy cast-iron or better still, semi-steel fittings may be used. For pressures below 100 pounds, cast-iron or malleable fittings of standard pattern may be used. In screwed fittings the collar over the threaded portion should be sufficiently heavy to prevent distortion when screwing up with pipe wrenches. Malleable iron is preferred by many on account of its lesser liability to rupture under stress. However, such fittings are generally lighter than cast-iron and are sometimes deformed in screwing up.

In central stations it is very common practice to find branch outlets welded to the main pipe and in general these welded pipes have given very excellent service. This practice is apparently very little used in marine work, although it would make a weight-saving construction by doing away with many cast-iron special fittings now used.

Valves.—Standard types of valves must be bought if one is to place orders in the open market under present conditions. Steel valves are used for superheat. Some shipbuilders even specify steel valves for all boiler pressures of 200 pounds or greater. If superheat is not used the valves may be extra heavy, of cast iron or semi-steel. These materials are also used for auxiliary steam lines. Bronze valves are sometimes employed in the smaller sizes, but these are very much more expensive than the extra heavy cast-iron valves and in sizes of 2½ inches and over have no advantage over them except in lightness of weight.

Valves 2½ inches and above must have bolted bonnets to comply with the U. S. Steamboat Inspection Rules. The marine or cross-head type of yoke is much superior to the standard cast yoke for ship purposes. It weighs less and is generally stronger and more readily repaired. It costs very little more than the cast yoke, but is not "standard" with many buildings.

It is customary on board ship to use the screwed-union bonnet on 2-inch and smaller valves. This type of valve is generally more expensive than the ordinary bonnet type, but has many points of superiority such as its regrinding facilities, longer life and less liability to damage when dismantling. Valve manufacturers generally make the screwed-union bonnet valves in two weights, one to withstand 200-pound pressure, the other for 350-pound pressure. It is therefore necessary to use the 200-pound valves for many low-pressure services. This has considerable advantages, for fewer types of valves need be bought and their interchangeability is increased.

Cast-iron or semi-steel valves for marine service are usually required to have a solid bronze disk with bronze seat. The stem may be of rolled phosphor bronze, rolled naval brass or manganese bronze. Gland studs and nuts should also be of bronze. Steel valves for superheat generally have monel-metal disks and seats with bronze or nickel-plated steel stems. The

bronze generally used for valve bodies, disks, seats, glands, etc., is the navy composition "M" consisting of copper 87 per cent, zinc 7 per cent, tin 6 per cent, and may contain lead up to 2 per cent in place of part of the copper. The lead content must be kept as low as possible on account of the action of the salt water.

It is the practice of many marine designers to specify a flange corresponding to extra heavy standard on the sea side of all sea valves, sometimes even when these are connected to the sea chests. Usually the valve is in all other respects of standard weight. This extra heavy flange adds nothing to the strength of the valve, for its weakest point is in the neck behind this flange, which is sometimes but not always made extra heavy. Some maintain that the extra heavy flange is needed to stiffen the ship plate. This same result is secured elsewhere by adding a reinforcing ring to the ship's plates. This type of valve is a "special" to the manufacturers and hence is high-priced and often difficult to obtain on reasonable deliveries.

Shipbuilders generally have endeavored to use A. S. M. E. standards for flanges and drilling. However, some criticisms have been heard. For instance, many marine engineers do not favor the raised faces on extra heavy flanges. They prefer flat faces. The flat faces are also favored for bolting to bulkheads and to other ship plates.

The bolting specified for certain sizes in the A. S. M. E. standards has not been satisfactory to many designers. For instance, in the 3-inch and 3½-inch standard-weight flanges the A. S. M. E. standard calls for four holes, while many marine designers use six holes. Also, in the 2-inch and 2½-inch extra heavy flanges the marine engineers frequently use six holes where the A. S. M. E. standards specify four. The A. S. M. E. standards increase the holes at one jump from four to eight. There seems considerable justification of the use of the 6-hole flange.

One cannot help commenting on the small use made of gate valves on ships. These are especially adapted to fuel-oil service and could be used to advantage on many water lines just as in land practice. A greater use of gate valves would relieve the existing valve shortage to an appreciable extent and also reduce friction. Reducing valves, relief valves, separators, traps, injectors, etc., can all be supplied equally well from the manufacturer's standard stock patterns made for central-station work as from special marine designs.

It is rather difficult to understand the basis for marine practice in heating systems. Live steam is usually passed through a reducing valve and supplied to the heating system at 20- to 30-pound pressure. The advantages of exhaust steam for heating and of steam bled from the main turbine do not seem to be fully appreciated in marine practice. Such uses of steam would make operation less simple, but would result in a thermodynamic gain, especially in passenger ships and troop transports.

Inspectors are frequently required to apply tests to valves. In general, such tests are specified in Lloyds and U. S. Steamboat Inspection Rules. A satisfactory standard for inspectors is to test all high-pressure steam valves under hydraulic pressure to three times their working pressure and to test all other valves to twice the working pressure corresponding to their weight or classification.—*Shipping*, 4/12.

COLLOIDAL FUEL.—The imperative need for increased supplies of liquid fuel, particularly for naval purposes, has prompted American engineers to investigate the problem of incorporating solid and liquid fuels in such manner that the resultant mixture can be handled and utilized as ordinary oil fuel. The work was carried out under the auspices of the Submarine Defence Association with the assistance of the United States Navy Department, and the results are of importance as they promise not only conservation of oil fuel, but also utilization of low-grade solid fuel.

The use of pulverized coal alone necessitates the adoption of special burning installations, and the difficulties connected with handling and storage render it impracticable as a naval fuel. Attempts made hitherto to blend any appreciable proportion of pulverized solid with liquid fuel have failed because of the sedimentation of the solid. The problem has, however, now been solved by the special incorporation of a "fixateur" whereby a liquid of colloidal nature is obtained. By this means 30-40 per cent of coal (95 per cent of which passes a 200-mesh screen) can be suspended in oil for several months without material sedimentation. The composition of the fixateur, which is used to the extent of 7 per cent, is not disclosed. Other substances (not specified) are incorporated, the properties of which have some particular influence upon the combustion and characteristics of the fuel, *e. g.*, dispersion of solid particles, miscibility, viscosity, flash point, melting point, ash and sulphur content, drying and inoculation. Some of these substances may remain in the final product, or, having fulfilled their function, may be distilled off for further use.

One grade of colloidal fuel was devised to utilize some poor quality "anthracite rice" containing 25.5 per cent of ash and having a calorific value of 10,900 B. Th. U. per lb.: 38½ per cent of this was incorporated with 61½ per cent of Pressure Still Oil, wax tailings, petroleum pitch, and fixateur running 18,505 B. Th. U. per lb. The product contained 10.2 per cent. of ash and had a calorific value of 162,500 B. Th. U. per gallon. The calorific value of the fixated oil itself was only 151,750 B. Th. U. per gallon. This increased heating value has an important bearing upon transport costs and upon the steaming radius of ships. Further research was directed towards the blending of petroleum oils and coal tars with coke and asphaltic substances. A stable liquid fuel was made up of oil 45 per cent, tar 20 per cent, and pulverized coal 35 per cent, thereby replacing over one-half of the oil. Asphaltic and free carbon particles in Pressure Still Oil may also be stabilized, thereby rendering a low sulphur oil available for metallurgical uses. (*Colloidal Fuel: Composites of Oil, Tar and Carbon*, issued by the Submarine Defence Association, New York.)—*Technical Supplement*, 5/27.

THE STILL ENGINE.*—There are two methods of producing power by the combustion of fuel—either under boilers or within the main cylinders of combustion engines. The greater part of the world's power is still derived from steam, which, owing to its proved reliability and greater adaptability to the services demanded of it, holds the field in competition with its rival, the internal combustion engine, but the latter shows a far higher heat efficiency. Yet it cannot start itself; cannot develop its full power, except at full speed; is a poor performer at low speeds; can only operate on moderate overloads for short periods; and may cease to operate, owing to a small defect, without warning. So combustion engines have as yet made little progress in competition with steam in locomotive work, and have supplanted steam but to a limited extent in marine and stationary engines.

The maximum ideal efficiency of a heat engine is obtained where the difference existing between the highest and lowest temperatures of the working fluid is greatest in proportion to the maximum temperature, and here the internal combustion engine, with an initial temperature higher than the furnace temperature of the boiler, and even higher than the melting-point of cast iron, is capable of realizing better thermal conditions than any other form of heat engine; but in its turn it suffers from two disadvantages—it ejects its working fluid at a temperature too high for ideal conditions, and it loses heat energy to a regrettable extent in the cooling of its cylinder.

* From a paper by Mr. Frank D. Acland, Royal Society of Arts, May 26, 1919.

The possibility of combining in one engine the superior thermal cycle at the high temperatures and pressures of the combustion engine with the low thermal cycle of steam to deal with its rejected heat, and, in the same engine, to add the superior working advantages of the steam engine, is the basis of work carried out by Mr. W. J. Still.

The Still engine is an engine capable of using in its main working cylinder any form of liquid or gaseous fuel hitherto employed; it makes use of the recoverable heat which passes through the surfaces of the combustion cylinder, as well as into the exhaust gases, for the evaporation of steam, which steam is expanded in the combustion cylinder itself on one side of the main piston, the combustion stroke acting on the other side. It increases the power of the engine, and reduces the consumption of the fuel per horsepower developed.

Its primary object is not to use the waste heat for raising steam, but first to use it in improving the thermal conditions of the working cylinder, and so ensure the maximum efficiency from the fuel burnt within it, diminishing, as a consequence, the heat lost in that operation. Since the maximum efficiency is obtained by combustion of the fuel in the cylinder, and the minimum by the evaporation of the water in the steam generator, it is evident that the larger the quantity of steam which can be generated per horsepower developed by the combustion cycle, the lower must be the heat efficiency of the whole machine.

In the Still engine—see diagram—the jacket and cooling water form part of the circulating system of a steam generator, which may be an integral part of the engine, or external to it. The cooling water therefore enters and leaves the jacket at a constant temperature, regulated by the pressure of the steam, the cooling being effected by converting the water into steam without raising its temperature. Excluding the radiation losses, which are kept low by lagging, all the heat which passes through the walls is thus usefully recovered in the water as steam. The temperature of the cylinder wall is uniform over the whole of its exterior surface, and the heat lost to the cooling water at each stage of the cycle—compression, combustion, and expansion—is diminished.

During compression, owing to the walls being at steam temperature, the incoming charge picks up heat instead of losing it during the greater part of the stroke, an advantage of the greatest value to the heavy oil types of Still engines, where an air charge is taken in at the full outstroke, and is compressed to a pressure where its increased temperature ensures the certain ignition and combustion of the fuel which is injected into it.

During combustion and expansion the uniform and higher mean temperature of the walls reduces the heat lost to the jacket water. Some of the heat thus economized adds to the useful work on the piston, the balance passing out in the exhaust gases for recovery.

To ensure the maintenance in a practical and reliable manner of the temperature conditions which produce this efficiency during the combustion cycle, a departure from the design and construction of the cylinders of normal internal combustion engines is imperative. The cylinder of a Still engine consists of an inner liner, which is approximately one-third to one-fourth of the usual thickness; it is ribbed externally so as to add to its conducting surface and provide suitable passage for the cooling water, and it is reinforced by an outer hoop capable of withstanding the highest pressures to be met with in working. No failure of a cylinder of any kind has occurred, even under most severe, even abnormal test conditions, *e. g.*, with mean combustion pressures of 180 pounds per square inch in a two-stroke engine, to which was added overload steam mean pressures of 70 pounds, *i. e.*, a total mean effective pressure per revolution of 250 pounds per square inch.

The Still engine may be of the constant volume or constant pressure type, or a combination of both; its losses to the cooling water are not the

same as in a normal engine of either type, except in so far that they vary with the type, with the cycle, with the efficiency of the combustion stroke, and with the load. At normal and full loads, such heat units, in a Still engine, as pass into the jacket water, which is at steam temperature and pressure, are lessened and are wholly recovered without loss—radiation excluded—in overcoming the latent heat of the water and give off their steam in the steam space in proportion to the heat flow at those loads. At lower loads less steam is produced, until at still lower loads no steam at all is measurable. In other words, the jacket losses are practically eliminated.

The exhaust gases take a subsidiary, but important, part in the cycle; their usefulness in ordinary combustion engines, in raising steam, is limited to the amount of heat recoverable between the initial temperature of the exhaust and that of, say, 50 deg. Fah. above the steam temperature, after which the whole volume passes away to atmosphere at a still useful temperature, less a small percentage available for feed-water heating. But in the Still engine the exhaust gases, after raising their quantum of steam, are employed in preheating all the water required for the steam generated in the jacket water and in the generator. Trials at full efficiency over long periods and steady loads show terminal stack temperatures as low as 150 deg. Fah. The heat efficiency of the combined cycles is therefore exceedingly good, with an initial temperature of over 2000 deg. Fah. and a final exhaust to atmosphere at 150 deg. Fah.

The quantity of steam capable of being generated from "waste heat" depends upon the efficiency of the combustion cycle, and on the load. Some years of experimental work prove that the weight of steam recovered may vary from a maximum of about 7 pounds per brake horsepower hour developed by the combustion cycle of a four-stroke constant volume engine at full load to a minimum at light loads which is hardly measurable, and which only balances the loss due to radiation.

The engine used for this research was of constant volume type, four-stroke. It first underwent a series of tests, so as to arrive at its "initial horsepower" as an explosion engine, *i. e.*, without any power added by the steam cycle, and was carefully checked in this connection by comparison with well-known and authenticated trials carried out by the late Professor Bertram Hopkinson, F. R. S., and others. Though it was a single-cylinder unit with automatic inlet valves, its "initial horsepower" was rated on a par with the power given by four-cylinder sets with mechanically operated valves deduced from tests over very short periods under their best conditions.

The quantity of steam generated per "initial brake horsepower" from the jacket alone averaged 3.28 pounds per brake horsepower hour, and from the jacket and exhaust together 6 pounds per brake horsepower hour, this being the average of the whole of the trials over periods varying from 20 minutes to over 6 hours. The final 6 hours of a 7½ hours' continued test gave a total recovery of 6.9 pounds of steam per initial brake horsepower. A whole series of these early trials was carried out under the supervision of C. Vernon Boys, F. R. S., whose sympathetic interest and encouragement is gratefully acknowledged as having largely contributed to the progress made since the inception of the system.

Normal load.—The average mean effective pressure from the combustion stroke was 90 pounds per square inch. The steam evaporated by the "waste heat" gave 14 pounds per square inch mean effective pressure on every return stroke. This is equivalent to $90 + 28 = 118$ pounds per square inch mean effective pressure in a normal four-stroke engine.

Overload.—By admitting additional steam generated by fuel under the boiler, the steam mean effective pressure was raised to 72 pounds per square inch; the total mean effective pressure was therefore equal to $90 + 144 = 234$ pounds per square inch mean effective pressure in a normal four-stroke engine.

Gas Engines.—The first experimental engine constructed was a two-stroke engine capable of developing 590 brake horsepower from three cylinders at 400 revolutions, bore 8-inch. It was a high speed engine, designed with special regard to obtaining data about the recovery of steam from waste heat (jacket and exhaust). It was first operated on town gas—540 B. Th. U.'s, and subsequently converted for oil fuel. Its efficiency was not high, owing to its being a two-stroke engine with a short stroke, but its consumption per brake horsepower was 15 cubic feet per hour (31.3 per cent efficiency), a very promising result.

The outbreak of war prevented much progress being made in the design and construction of gas engines; but the results achieved give great promise of future development, for with a combustion indicated efficiency of 36 per cent, radiation 4 per cent, boiler loss 10 per cent, there remains 50 per cent for recovery; allowing 10 per cent efficiency for the steam cycle, a gain of 5 per cent is assured, and the total indicated efficiency of the engine will not be less than 41 per cent. If 20 per cent efficiency is obtained from the steam cycle, as appears possible, the total indicated efficiency will be 46 per cent.

A gas engine which can give a brake thermal efficiency 30 per cent better than its predecessors, and which, by governor control alone can meet any demand up to and over 100 per cent overload, while maintaining a good efficiency at that increased output, cannot be neglected.

Petrol and Oil Engines.—Four-stroke engines for petrol and similar fuels have been built and tested ashore and afloat.

A three-cylinder set (marine type) capable of developing on its three small cylinders at 600 revolutions per minute twelve 5-shaft horsepower at 90 pounds combustion mean effective pressure, without power from the steam stroke, gave on continuous running 16½ shaft horsepower under "waste heat" conditions, maintaining from the "waste heat" a steady boiler pressure of 100 pounds, with sufficient reserve for maneuvering in narrow waters or bringing up. It would pick up very rapidly when ignition recommenced, and bring up the boiler pressure to normal in a few minutes.

With the addition of a burner below the boiler it would run continuously and develop 38 shaft horsepower at 750 revolutions. Momentary overload in proportion to the capacity of the boiler reached 60 indicated horsepower (51.5 shaft). Under steam alone the engine is a most satisfactory performer, but not economical.

The Still oil engine starts with the cylinders and pistons preheated. The air charge, from the moment of its entry into the cylinder, picks up heat from the containing walls and continues to do so during at least 70 per cent of the compression stroke, with the result that the temperature necessary for firing with certainty the first injected charge of fuel is reached with a compression pressure 50 per cent less than that required in a Diesel engine.

This fact is far reaching in its importance, for it gives to the designer great elasticity and freedom of application, for a Still heavy oil engine can be designed for constant pressure or constant volume, or both can be employed in the same engine by correct timing of the fuel injection. It claims for its combustion cycle an efficiency higher than that of the Diesel, less weight and space per horsepower, and for its combined cycle an efficiency not less than 20 per cent higher than any prime mover which uses fuel as its source of heat.

The first engine designed for the use of heavy oil was of the opposed piston type, 16-inch diameter, 32-inch total stroke, revolutions 150, the combustion taking place between the two pistons with the steam generated by the jacket water and exhaust gases expanded at the back of both pistons—the steam passed from the auxiliary boiler through high-pressure and intermediate-pressure cylinders, and finally to the Still engine as a low-pressure cylinder—and thence to the condenser.

In a special engine subsequently constructed to meet special conditions—where the maximum power in minimum space was the main desideratum—the dimensions of the cylinder were: Bore, 13½ inches, stroke 22 inches; two-stroke cycle, opposed pistons; steam side as for low-pressure cylinder. It forms the basis of a six-cylinder set, two of them using high-pressure steam, which is compounded into the other four as low pressure.

The combustion takes place between the pistons, the steam acting on the return stroke at the back of both pistons. After a series of preliminary tests under steam alone, in which data was obtained for the various mechanical adjustments, the scavenge, compression pressures and temperatures, at various speeds, oil was injected for the first time. The engine fired its first charge without hesitation, and completed a series of tests of over two hours' continuous running, without adjustment, giving an output by gradually increasing the weight of oil admitted of 100, 150, 200, etc., up to 400 indicated horsepower at a maximum speed of 380 revolutions per minute, for which she was designed.

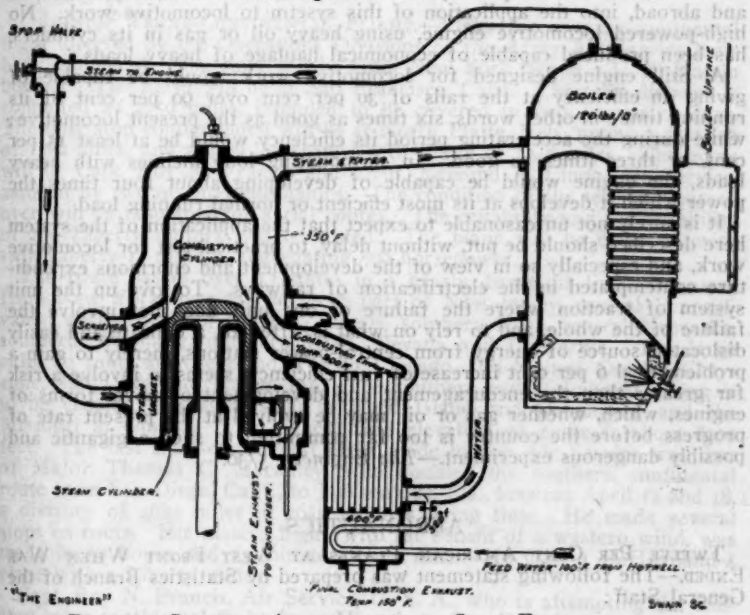

DIAGRAM SHOWING ARRANGEMENT OF STILL ENGINE.

This unit has been subjected to many long and varied tests by representatives of various governments, as well as to constant research work under severe conditions. Its best consumption of fuel—Admiralty shale oil—has been as low as .302 pound per brake horsepower—scavenge pump not included—over a test of one hour's duration under normal waste heat conditions. It developed 330 brake horsepower for six hours at 360 revolutions per minute—a single cylinder—under waste heat conditions. It will develop 400 brake horsepower continuously with added steam, and has developed 540 brake horsepower at 380 revolutions over short periods. (Combustion mean effective pressure 128.2 pounds, steam mean effective pressure 57.9 pounds, total mean effective pressure 186.6 pounds.) The thermal brake efficiency from below quarter load to full power is maintained at approximately 40 per cent over the whole range.

With added steam from the boiler 5000 brake horsepower would be obtained from two 6-cylinder sets, with a weight of about 70 tons, including all auxiliaries and water, and extreme overloads up to 6000 brake horsepower could be obtained.

The application of the Still system to commercial marine work is being developed in this country and abroad, the two-stroke single-piston type, in powers of 100 horsepower per cylinder and 400 horsepower per cylinder, having been adopted.

Engines of this type at 120 revolutions per minute, with a cylinder 22 inches diameter by 36 inches stroke, giving 4200 shaft horsepower on two shafts, with all auxiliaries and water, would approximate 600 tons. A geared turbine plant in a similar ship would weigh 20 per cent more, and would consume approximately 2000 tons more fuel for a double journey lasting 1000 hours.

Locomotives.—The success already achieved in proving the principles to be correct, both in theory and practice, has led to a careful study, both here and abroad, into the application of this sysetm to locomotive work. No high-powered locomotive engine, using heavy oil or gas in its cylinders, has been produced capable of economical haulage of heavy loads.

A Still engine designed for locomotive work would be capable of giving an efficiency at the rails of 30 per cent over 90 per cent of its running time—in other words, six times as good as the present locomotive; while during the accelerating period its efficiency would be at least 15 per cent, or three itmes as good. In surmounting long inclines with heavy loads, the engine would be capable of developing about four times the power which it develops at its most efficient or normal running load.

It is surely not unreasonable to expect that the application of the system here described should be put, without delay, to practical test for locomotive work, and especially so in view of the development and enormous expenditure contemplated in the electrification of railways. To give up the unit system of traction where the failure of one unit does not involve the failure of the whole, and to rely on what is, after all, a delicate and easily dislocated source of energy from central-power stations, merely to gain a problematical 6 per cent increase of fuel efficiency, seems to involve a risk far greater than the encouragement and development of novel forms of engines, which, whether gas or oil, may be evolved at the present rate of progress before the country is too far committed to such a gigantic and possibly dangerous experiment.—*The Engineer*, 5/30.

AERONAUTICS

TWELVE PER CENT AMERICAN PLANES AT WEST FRONT WHEN WAR ENDED.—The following statement was prepared by Statistics Branch of the General Staff:

COMPARISON OF AEROPLANE STRENGTH OF ALLIES AND ENEMY AIR SERVICE AT DATE OF ARMISTICE

French and Belgian front	Number of Planes
French	3,321
German	2,730
British	1,758
American	740
Belgian	153
Total Allied	5,972
Total Enemy	2,730
Italian front	
Italian	812
Austrian	622

COMPARISON OF BALLOON STRENGTH OF ALLIED AND ENEMY AIR SERVICES AT DATE OF ARMISTICE

French and Belgian front	Number of Balloons
German	170
French	72
British	43
American	23
Belgian	6
Total Allied	144
Total Enemy	170
Italian front	
Italian	32
Austrian	26

—*Aerial Age Weekly*, 6/9.

ONE-STOP TRANS-CONTINENTAL FLIGHT.—Plans for a trans-continental flight directed by the Operations Divisions of the Army Air Service have been completed. The start will be from New York city in a U. S. Martin bomber. The finish will be at San Francisco, Calif. The total distance is computed as 2750 miles, intended to be covered in two successive days. The only stop contemplated will be at North Platte, Neb., giving a first leg of 1502 miles, and a final leg from North Platte of 1248 miles. The pilots will be Capt. Roy N. Francis and Lieut. Edmund A. Clune, Air Service, assisted by two or three mechanics. The condition of the territory passed over will be tabulated for aerial routes. The reliability and the durability of the Liberty motors will be tested. The plane will be equipped with twin Liberty-12 motors, aggregating 800 horsepower.

The route passes over 13 states in a nearly direct air line. It passes from New York over the northern part of New Jersey, central Pennsylvania, northern Ohio, Indiana, Illinois, southern Iowa, central Nebraska, southern Wyoming, northern Utah, Nevada and California. The large cities en route are Cleveland, Toledo, Chicago, Des Moines, Omaha, Cheyenne, Salt Lake and Sacramento. The southern end of Lake Michigan is to be crossed, the Mississippi at Rock Island and Davenport, and the Missouri at Omaha. The highest land elevation en route is about 8000 feet. The last trans-continental flight made by the Air Service was that of Major Thomas C. Macauley, who doubled the southern continental route from San Diego, Calif., to Jacksonville, Fla., between April 12 and 18, a distance of 4642 miles in 2655 minutes flying time. He made several stops en route. His eastern flight, with the benefit of a western wind, was made in 19 hours and 15 minutes flying time. He used a DeHaviland-4 plane with a Liberty motor.

Capt. Roy N. Francis, Air Service, U. S. A., who is attempting the one-stop trans-continental flight from Mineola to San Francisco, is one of the foremost instructors of fliers in the United States. At Kelly Field, Texas, during the period of hostilities Captain Francis taught and trained more than 1500 men who qualified as military aviators, a greater number than any other American instructor so far as known, and probably more than any one foreign instructor. Since the armistice he has been performing regular flying duty and has taken on short flights groups of Senators and Representatives. Captain Francis did all that was humanly possible to have the War Department assign him to foreign service as a pilot, but his ability as an instructor was regarded as so valuable that he was disappointed in his ambition to fight the enemy in the air.—*Army and Navy Journal*, 6/7.

MISCELLANEOUS

JOFFRE EXPECTED 500,000 FROM U. S.—"I happened to remember the other day that when Marshal Joffre was in this country he and I had a very long, confidential conversation with regards to America's participation in the world war, and I asked the Chief of Staff if I could have a memorandum

of that conversation. I did not succeed in finding it, but I found a report of a conference between Marshal Joffre and the General Staff.

"This conference took place early in May, 1917. Marshal Joffre urged strongly that we immediately form a single division of troops and send them to France to stimulate the flagging spirits of the French. They had undertaken a great offensive, which had failed with a tremendous and disheartening loss of life; and he felt that nothing would serve to revive that flagging morale more than the appearance of the American soldiers at the front.

"He urged that we should form a great army, with the expectation of ultimately participating in great force on the western front. He said that a port would be placed exclusively for our disposal and that it would be adequate for our work for a very long time, more than adequate to land this single division and supplies—perhaps not quite adequate for our great army when it came, because, he said:

"'When your great army comes, you will have 400,000, perhaps as many as 500,000 men, and you will need more port facilities for them.'

"The wildest expectation of the French General Staff was that, when America finally did pull herself together and prepare to participate on the western front, we would have as many as 400,000 to 500,000 men. As compared with the performances of a great army of 400,000 or 500,000 men the thing which America finally did was that in June, one year and two months after we declared war, we were selecting, training, equipping, transporting, and maintaining soldiers in France at the rate of 10,000 a day. In the single month of June, 1918, we transported nearly as many men as the Marshal had expected us to put in our great army as the maximum of his great expectation. And, when the armistice did come to pass, we had in France over 2,000,000 men and our casualties on the western front were pretty nearly as great as the maximum expectation of the Marshal for our entire army.—From speech by Secretary Baker in New York, *N. Y. Times*, 6/13.

TO SURVEY NORTHERN PACIFIC WATERS.—There entered the Pacific Ocean through the Panama Canal recently the Government's new vessel built for the Coast and Geodetic Survey, very properly named the *Surveyor*, en route for Alaska from Norfolk, Va. She is probably the most modern ocean-going surveying vessel in existence. She is a steel, steam vessel of 1000 tons displacement, of 1321 indicated horsepower, and has a speed of 12 knots. Her complement is 11 officers and 56 men. She was designed along lines that would give her the maximum possible seaworthiness, steaming radius, and maneuvering qualities in a craft of her size. High speed was not considered essential, but was sacrificed for steadiness and seaworthiness.—*Nautical Gazette*, 6/14.

CURRENT NAVAL AND PROFESSIONAL PAPERS

Civil Engineering in the War. Work overseas. Major-Gen. Sir G. R. Scott-Moncrieff. (*Times Engineering Supplement*, May, 1919.)

Panama Canal-Zone Dry Docks and Repair Shops. R. D. Gatewood. Illus. (*American Machinist* [European Edit.], May 3, 1919.)

The French Army Motor Service: Its Organization and Working during the War. (*Génie Civil*, Apr. 12, 1919.)

New Orleans Army Base Improves Facilities of the Port. G. H. Davis. Three concrete warehouses tied to 2000-foot wharfhouse on river by bridge permitting access to all floors. Rail and water connections and storage facilities make peace-time use important. Illus. (*Engineering News-Record*, Apr. 24, 1919.)

Railway Gun Mounts. Lieut.-Col. C. M. Barnes. Illus. (*American Machinist* [European Edit.], May 3, 1919.)

New Express Locomotive with "Uniflow" Cylinders, North Eastern Railway. A class "Z" 3-cylinder engine which will provide a useful comparison with others of the same series, but having ordinary ported cylinders. Illus. (*Railway Gazette*, May 9, 1919.)

Special Train for the Commander-in-Chief in France. Illus. (*Railway Gazette*, May 9, 1919.)

Ford Methods in Ship Manufacture. Electric rivet heating and welding, flame cutting and boring propeller shaft bearings. Serial. F. E. Rogers. (*Industrial Management*, May, 1919.)

The Building of Concrete Ships. The "Monolithic" and "Unit" systems. Illus. (*Modern Transport*, May 17, 1919.)

The Kitchen Reversing Rudder. Illus. (*Engineering*, May 16, 1919.)

War-Time Repairs in the American Navy, Boring and Lining Operations. This article explains the principal features of the system for taking care of the many jobs handled by the repair ship. Relining a set of connecting-rod brasses is also described, together with details connected with the necessary boring of the lining. The method of setting up the work on the horizontal boring machine is given. Serial. Illus. F. A. Stanley (*American Machinist* [European Edit.], May 10, 1919.)

Electrically-driven Ships' Auxiliaries. Illus. (*The Engineer*, May 16, 1919.)

Marine Boilers Standardized. Some critical comments. (*Times Engineering Supplement*, May, 1919.)

Water-Tube Boilers for Cargo Ships. (*The Engineer*, May 16, 1919.)

Modern Marine Engine Economies. Some notes on the efficient operation of ships' engines and boilers. (*Shipbuilding and Shipping Record*, May 8, 1919.)

Civil Aviation and the Air Routes of Great Britain. Map. (*Flight*, May 1, 1919.)

Air Navigation. The most important of the unsolved problems relating to aviation. Major H. E. Wimperis. Map. Diagrams. (*Aeronautics*, May 8, 1919.)

Medical and Surgical Aspects of Aviation. H. Graeme Anderson. (*Aeronautics*, May 8, 1919.)

Engineering Achievements of the U. S. Army. (*Mechanical Engineering*, April, 1919.)

Reorganization of the American Engineering Standards Committee. Serial; Erit. B. Rosa. (*Engineering News-Record*, May 1, 1919.)

DIPLOMATIC NOTES

FROM MAY 20 TO JUNE 20

PREPARED BY

ALLAN WESTCOTT, Associate Professor, U. S. Naval Academy

GERMANY ACCEPTS PEACE TERMS

DISCUSSION EXTENDED TO MAY 29.—At the request of the German delegation, the time accorded for discussion of peace terms was on May 20 extended seven days, from May 22 to May 29. The request was based on the ground that the German delegation had in preparation several notes containing suggestions of a practical character which could not be completed in the period of 15 days originally allotted. These were listed as follows by Count von Brockendorff-Rantzau in his request of May 20:

First—a note concerning territorial questions in the east; second, a note concerning Alsace-Lorraine; third, a note concerning the occupied territories; fourth, a note concerning the extent and discharge of the obligation undertaken by Germany in view of reparation; fifth, a note concerning the further practical treatment of the question of labor laws; sixth, a note concerning the treatment of German private property in enemy countries.

These notes were submitted, but their contents were for the most part covered in the general reply sent by Germany on May 29.

In the American press of May 24 appeared the full text of the German communication (May 16) regarding the effect of the peace terms on the German people, and also the reply of the Allies (May 22). To the complaints of Germany, the Allies replied: (1) That the peace terms reduced the population of Germany from 67 million to 61 million; (2) that the four million tons of shipping taken from Germany constituted less than one-third of the tonnage sunk by submarines; (3) that Germany could import goods and still be prosperous; and (4) that in general the hardships laid upon Germany were the result and just punishment of her own acts.

The text of the German note on boundaries (May 15) and on the Sarre Basin (May 16), together with the replies of the Allies (May 24), was published in the American press of May 26. Certain alterations in these matters appeared in the final terms.

GERMAN REPLY OF MAY 29.—The German reply to the peace terms submitted on May 7 was received on May 29. The covering letter of Count von Brockendorff-Rantzau appeared in the American press of June 2, and a summary of the entire note on June 16. The note contained about 60,000 words.

The covering letter was in effect a summary of the entire reply. It declared that the terms were "impossible," "more than the German people can bear," and that "Germany, thus cut in pieces and weakened, must declare

herself ready in principle to bear all the war expenses of her enemies, which would exceed many times over the total amount of German public and private assets."

The reply begins with an analysis of the legal basis of peace, alleges a flagrant series of contradictions to this basis and points out that the results would be the complete enslavement of the German people and the betrayal of all the world's cherished hopes of peace.

In the counter proposals Germany demands immediate admission to the league of nations as part of the spirit of the armistice agreement and as necessary for the acceptance of the proposed military, naval and air terms. She then analyzes the territorial changes demanded, claiming that the right of self-determination has been wilfully violated throughout.

Germany bitterly assails the abolition of all German rights outside of Europe as irreconcilable with the preliminary negotiations and as wholly impossible to a great people, who not only have supreme needs for markets and supplies, but who have shown themselves capable of sharing the world's colonization.—*Associated Press,* June 15.

FINAL TERMS SUBMITTED ON JUNE 16.—The reply of the allied and associated powers containing the final terms to Germany was handed to the German delegates and made public on June 16, with a period of five days (extended later to seven) for acceptance or rejection. The principles of the original terms were followed out, with modifications in detail and explanations. The changes included:

A plebiscite for upper Silesia, with guarantees of coal from that territory.

Frontier rectifications in West Prussia.

Omission of the third zone in the Schleswig plebiscite.

Temporary increase of the German Army, from 100,000 to 200,000 men.

Declaration of the intention to submit within a month of signature a list of those accused of violations of the laws and customs of war.

Offer to cooperate with a German commission on reparations and to receive suggestions for discharging the obligation.

Certain detailed modifications in the finance, economic and ports and waterways clauses, including abolition of the proposed Kiel Canal Commission.

Assurance of membership in the League of Nations in the early future, if Germany fulfills her obligations.

CONDITIONS FOR ADMISSION TO LEAGUE OF NATIONS—The conditions for Germany's admission to the League of Nations were inserted in the treaty on the basis of a report submitted by Lord Robert Cecil and Colonel House, as follows:

First—The establishment of a stable government.

Second—The signing of the treaty of peace.

Third—The loyal execution of the peace treaty.

A proposed fourth condition relative to Germany's abolishing compulsory military service was finally omitted on Premier Clemenceau's suggestion. It was considered that the treaty sufficiently provided for Germany's disarmament.

GERMANY'S REPLY.—Immediately upon receiving the final terms, the German delegates left for Weimar, where a meeting of the German cabinet was held on June 17, in preparation for submitting the German answer to the national assembly.

U. S. SENATE SEEKS PART IN NEGOTIATIONS

INVESTIGATION OF TREATY "LEAK."—On June 6, following statements by Senators Lodge and Borah that several copies of the Peace Treaty were in circulation in New York and elsewhere, the Senate passed a resolution introduced by Senator Hitchcock for an investigation of the treaty "leak." Subsequent testimony revealed that a copy had been given to Mr. Henry P. Davison upon his return to New York by Mr. Thomas W. Lamont, associated with the American delegation as a financial expert. Ex-Senator Root pointed out to the Senate Investigating Committee that, upon its publication by Germany, the treaty was no longer a private document.

To the Senate's request for a copy of the treaty, President Wilson on June 16 replied through the Secretary of State that "it would not be in the public interest to communicate officially to the Senate a text which is provisional and not definite, and he finds no precedent for such a procedure."

KNOX RESOLUTION AGAINST LEAGUE OF NATIONS.—Senator Knox, on June 11, introduced in the Senate a resolution expressing opposition to any treaty provision which would in effect amend the Constitution of the United States, and advising that the treaty be so drawn as to permit states to ratify without taking action regarding the League of Nations. This resolution was favorably reported by the Committee on Foreign Affairs, but was not put to a vote in the Senate.

RESOLUTION FOR IRISH HEARING.—On June 6 the Senate passed a resolution requesting the American Peace Delegation to secure a hearing for the cause of Ireland before the Peace Conference. According to reports from Paris, it was the President's intention to submit this request without comment.

PEACE TERMS TO AUSTRIA

DR. RENNER'S ADDRESS.—The Allies presented peace terms to the Austrian delegates at St. Germain on June 2. By his reply, delivered standing and in French, Dr. Karl Renner, the chairman of the Austrian delegation, made a favorable impression. He referred to the Austrian republic as completely divorced from the old Hapsburg monarchy, and as one of eight nationalities which had "over-night created their own parliaments, their own governments, their own armies, in short, their own independent states."

Regarding Austria's relations with other former parts of the empire and with the Allies, he spoke as follows:

Between them and us it is not a question of making peace, but of liquidating the former partnership and settling the future relations under the intervention and guarantee of the powers, for which we pray. Nevertheless, these succeeding states, meeting face to face in Paris, play quite a different rôle in regard to their obligations assumed in the past. We expect to eliminate this contradiction at the Peace Conference. I reserve to myself the opportunity of drawing like conclusions from this contradiction later on.

We are before you as one of the parts of the vanquished and fallen empire. We assume our portion of the liabilities, growing out of these our relations to the Allied powers, and we are well aware of the fact that our fate is resting in your hands.

We hope and believe that the conscience of the world shall not deny to our people, nor curtail, the inalienable right of self-determination, which the associated powers have always proclaimed to be the very aim of their war waged against the Hapsburg and the Hohenzollern monarchies, a right which our people, confiding in the principles recognized by the Allied powers, have adopted as a fundamental basis of their new constitution.

We trust that the world's common sense will not have in view, nor will permit, our economic ruin. The destruction of the economic unit of the monarchy, the separation of our mountainous country from all its national resources, has condemned us, these last six months, to privations which are by far exceeding the sufferings endured in war time.

The latter part of the address suggested Austria's desire to unite with Germany, as a matter of economic necessity. Having received the treaty terms, the Austrian delegates returned to Innsbruck for a conference with members of their government. After Germany's example, June 6 was declared a day of mourning over the peace requirements.

TERMS OF PEACE.—While the officially published summary of the Austrian peace terms was marked chiefly by its omissions, it revealed that the military terms and those relating to the League of Nations were in general identical with those offered to Germany. Details of frontiers, especially the Italian, were for the most part omitted. Provision was made for the rights of minority peoples in the various new states. A summary follows:

The treaty will consist of a preamble and 14 parts, the preamble and Section 1 embodying the covenant of the League of Nations, as in the treaty with Germany.

Part II deals with frontiers. The boundary between Austria and Czecho-Slovakia follows practically the old Bohemian frontier, although with the reservation of a possibility of making minor changes later. Austria retains on the west her old frontier with Switzerland, the question of the union of Voralsberg with Switzerland having apparently been dropped, despite the plebiscites already undertaken in that province and Switzerland. The southern frontier is not determined in the treaty.

Part III contains political clauses, including also some of the reserved geographical provisos, and clauses establishing mixed commissions to determine them later.

The sections referring to Italy are all omitted.

Others deal with the future relations of Austria with Czecho-Slovakia, Jugo-Slavia, Poland, Hungary and Russia. Here are found the stipulations for the protection of racial minorities, which, so far as the minorities in Austria are concerned, are to be embodied in a "bill of rights," as part of the Austrian Constitution.

Then come parts dealing with Austria's renunciation of all rights outside of Europe, military, naval and aerial armaments, which hereafter will entail virtually no expense for Austria, and the return of prisoners of war.

Part VIII, on reparations, is blank. Part IX, dealing with finance, may be changed as a result of the representations of the new states. The economic clauses and aerial navigation regulations are identical with those in the German treaty.

Part XII, on ports, waterways and railways, provides for commercial outlets southward by water and rail. These details have already been covered in the report of the Inter-Allied Ports, Waterways and Railways Commission. Part XIII contains the international labor convention, and Part XIV various miscellaneous provisions of minor importance.

BELA KUN REPLIES TO PEACE CONFERENCE NOTE.—In reply to a note from President Clemenceau, the contents of which were not revealed, Bela Kun, the Hungarian Communist Foreign Minister, expressed his willingness to cease hostilities with the Czecho-Slovaks, although he claimed that the Czecho-Slovaks themselves were responsible for violations of the frontier established by the Allies. The Hungarian leader suggested the appointment of a commission to settle these disputes, and closed by expressing satisfaction that the Allies had invited Hungary to the conference.

In Paris circles it was not admitted that a direct invitation had been extended to Bela Kun, nor was it regarded as certain that he would cease hostilities undertaken "for the liberation of the Czecho-Slovak proletariat."

SCHEME FOR RHINE REPUBLIC

Apparently with the sanction of French military and political authorities, a Rhenish republic was proclaimed at Wiesbaden on June 1. Dr. Dorten, a former state's attorney, became head of the new government and sent telegrams to the Paris Conference on June 2 announcing the proclamation of the republic by delegates assembled at Wiesbaden, and declaring popular support for the movement. As shown by later developments and reports from American sectors in the Rhineland, there was in reality little popular sympathy behind the move to separate the Rhine provinces from the rest of Germany.

PROTESTS FROM BERLIN.—Berlin, June 3 (Associated Press).—The German Armistice Commission has handed to Marshal Foch a note for the Allied powers protesting against French support of the proclamation of a Rhenish republic as high treason against Germany, and complaining of Colonel Pinot's threats and actions at Weisbaden. The note concludes:

"This action on the part of the French occupation authorities is in sharpest contradiction to the armistice conditions and represents the grossest violation of obligations legally undertaken. The German Government makes the sharpest protest against this behavior."

In response to Dr. Dorten's notification of the proclamation of a republic, the German Chancellor, Philipp Scheidmann, has ordered the prosecution of Dorten and the other members of his government for high treason, and has declared all the official acts of the new government void.—*N. Y. Times*, 4/6.

ASSERT FOCH'S APPROVAL.—The only support in Germany for the separatist movement seems to have come from members of the Catholic center party. According to a Mannheim despatch of June 4, General Gerard of the French Army was approached in the matter by two Centrist members of the National Assembly on March 8. The delegates received assurances of protection from French authorities, including Marshal Foch, who was quoted as declaring the establishment of one or more independent Rhine states inevitable.

The Berlin government on June 6 appointed Karl Trimborn, a leading member of the Centrist Party, as regional president of the Rhineland. This was regarded as a concession to republican sentiment in the Rhine country, and as a counter-measure against the separation movement.

RUSSIA

ALLIES PLEDGE SUPPORT TO KOLCHAK.—On May 26 the allied and associated powers sent to the All-Russian Government at Omsk a note which, it is understood, offered the Omsk Government support, including munitions and supplies, on condition that the Omsk Government should accept the decisions of the Peace Conference and assure self-government in Russia.

To the terms of this note, Admiral Kolchak gave a conditional acceptance, summarized as follows:

Paris, June 7 (Associated Press).—Further details of the reply of Admiral Kolchak, head of the government at Omsk, to the Entente conditions for the recognition of his government became known to-day. He has made two exceptions to the proposals. He agrees to call a Constituent Assembly with full powers, but takes exception to the alternative in the Entente offer that the old Constituent Assembly elected in 1917 should be recalled in case it proves impossible to form a new one immediately after his arrival in Moscow.

He declares that the old Constituent Assembly was elected irregularly, before the Bolshevist doctrines were discredited, and, consequently, the members elected are not representative of present-day Russia.

He also takes exception to the provision that Finland as an independent state shall be represented, stating that this is a matter on which the Constituent Assembly must decide.

He concedes Polish independence, as that was approved by a democratic Russian Government, functioning regularly.

According to the Havas Agency, Admiral Kolchak says that while his government has already recognized the independence of Poland, the final frontiers will have to be adjusted by mutual agreement, and that his government will accept the assistance of the various non-Bolshevist governments in solving the difficulties during the period of transition prior to the establishment of a regular government.

Concerning the Russian debts, Admiral Kolchak reiterates the decision of his government to pay all debts contracted by the various governments up to the Bolshevist revolution of November, 1917.

ALLIES' NOTE OF JUNE 12.—Paris, June 12 (Associated Press).—The reply sent by the Council of Four to-day to the note of Admiral Kolchak extends to him and his associates in the All-Russian Government at Omsk what is interpreted here as de facto recognition. The note reads:

"The allied and associated powers wish to acknowledge the receipt of Admiral Kolchak's reply to their note of May 26. They welcome the terms of that reply, which seem to them to be in substantial agreement with the propositions they had made and to contain satisfactory assurances for the freedom, self-government and peace of the Russian people and their neighbors.

"They are therefore willing to extend to Admiral Kolchak and his associates the support set forth in their original letter.

LLOYD GEORGE,
WILSON,
CLEMENCEAU,
MAKINO."

It is understood that the support referred to involves the furnishing of munitions and supplies for Admiral Kolchak's campaign.

The Havas Agency says Premier Orlando of Italy also signed the document.

An official statement issued by Admiral Kolchak states that he has appointed a commission, headed by M. Billareugsoff, to make a study of constitutional questions preparatory to the framing of a constitution which will be submitted to the proposed Constituent Assembly.—*N. Y. World*, 13/6.

AMERICANS LEAVE NORTH RUSSIA.—According to an Archangel despatch of June 6 all the American forces will be withdrawn from the North Russian front by the last of June. The second contingent to leave was then assembled at Economia, the winter port of Archangel, and was expected to sail within 10 days. The total casualties of American forces on the North Russian front was stated to be 556.

FAR EAST

CHINA WILL SIGN TREATY, WITH RESERVATIONS ON SHANTUNG.—Paris, May 24.—Luther G. Chang and C. E. Wang, two of the ranking Chinese delegates, said today that they would probably sign the Peace Treaty with a reservation stating that they did not waive their claim for the transfer of German rights in Shantung to China direct and did not recognize the transfer to Japan.

The Chinese are unable to sign the treaty without reserve because the situation in China is acute, but they are eager to see China become a member of the League of Nations and to share the benefits resulting from the opium agreement.

Anti-Japanese agitation increased in China with the announcement of the treaty terms relating to Shantung. Mass meetings assembled in various cities, and it was reported that all institutions of learning in Pekin had gone on strike in protest. A boycott of "enemy" Japanese goods was declared at Shanghai and other ports. According to a Tokio despatch of June 11 several Japanese warships had been sent to Shanghai.

ALLIES ASSURED OF PEACE IN CHINA.—Peking, June 6 (Associated Press).—The British Minister, Sir John N. Jordan, on behalf of the diplomatic body in Peking, yesterday tendered an aide memoire to President Hsu Shih-chang, in which the powers expressed deep regret at the suspension of the Shanghai Conference which had been endeavoring to effect conciliation between North and South China.

In reply President Hsu Shih-chang stated that, although the Shanghai Conference had come to a standstill, the negotiations for peace between North and South China were still in progress. The President assured the British Minister that the government was determined to secure peace, and that it was impossible that hostilities would be resumed.—*N. Y. Times*, 8/6.

REVIEW OF BOOKS
ON
SUBJECTS OF PROFESSIONAL INTEREST

"The Battle of Eastleigh, England." By the members of the U. S. N. A. F. stationed at Eastleigh, England. Price $2.50 net. (Published by Thomson Company, 9 Murray St., New York.)

In view of obstacles so successfuly overcome by the force that established and operated the assembly and repair base at Eastleigh, England, the title is appropriate, though the book contains little of blood and sudden death. It is a "Lucky Bag," compiled by the members of the U. S. N. A. F. stationed there, as a memento of their work and play from the establishment of the base, July 23, 1918, to its breaking up on December 2, 1918.

As with all such books, its appeal is principally to those to whom jokes on "Bill," or "Joe," there stationed, bring chuckles of remembrance. A large portion of the book is given up to short biographical sketches of the officers and chief petty officers of the station and to a muster-roll of the non-commissioned personnel. Short accounts are given of the work of the several departments, together with a short history of the establishment of the "Northern Bombing Group," leading up to the selection of Eastleigh as a sight for the assembly and repair base. The book is profusely illustrated with photographs of the station, of personnel and of planes.

L. A.

"Morals and Morale." By Luther H. Gulick.

It was said that many things, the submarine, the aeroplane, food, and even tobacco, would win the war, but the thing which really did the most for victory was the morale of the A. E. F. How the morale was dependent upon morals and the important part played by the Y. M. C. A. for this great cause, was the object of Luther H. Gulick in writing this book. The appearance of the book, after the death of the author, seems to give increased weight to his work for the welfare of the soldiers and sailors and entitles his thoughts and words in their behalf to greater consideration. Clean living is the essence of the book; the need of it and the efficiency of it are demonstrated among men who are training for winning a football game, as well as for winning the world's war. The following quotation is from the chapter on morals and morale, and is quoted because it shows the spirit of the subject in a few words: "The college man now who is playing on a big team and is struggling for the victory of his college, would face an outraged college spirit, if, before a great game, he indulged in dissipation, because he would by that act decrease the probability of a victory for his college." This good spirit is the morale of the team and

of the students, it is necessary for the fair name of their college; much more is it needed among the fighters for the fair name and glory of their country.

Never before, in all the wars of all the nations, has such stress been laid upon "cleanliness," and it is the first time that venereal diseases have been so recognized (not as a necessary evil), and so many steps taken to guard against them, as: general orders issued by the commander-in-chief, lectures and motion picture demonstration by medical officers, a special social hygiene division having been established for this purpose, and all the safeguards of the red triangle of the Y. M. C. A. having been thrown around the men. The result is now known to all the world, the war has been won and there is nothing but praise for the morals and morale of the Americans—but the work of the Y. M. C. A., at home and abroad, is not finished, but just begun in the larger field of reconstruction.

Read the book to find out what is planned to be done after victory for the future of Democracy and the welfare of the people of the world who have suffered so much from the lack of morals.

A. M. D. McC.

"Aviation Engines." By Lieut. (J. G.) John C. Chadwick, U. S. N. R. F. (Published by Edwin N. Appleton, Inc., New York City.)

This is a very small book setting forth briefly the main features and principles employed in internal combustion gasoline engines. The subject is treated in non-technical language and is arranged in a manner adapted for easy reading.

As stated by the author: "The purpose of this book is to give anyone desiring to operate an airplane, a fundamental understanding of engines as used. It is founded on the course of instructions as given at the U. S. Naval Aviation Detachment, Massachusetts Institute of Technology, in training pilots for service. It is not intended for purposes of design, criticism or recommendation, but simply for instruction of the average individual, assuming he knows nothing of a gas engine."

The author describes and gives the engine characteristics of three of the principal engines used in the field of aviation, including the Liberty, Curtiss and the Hispano-Suiza.

A very handy little "trouble chart" is included in the book.

W. L. L.

"Wrinkles in Practical Navigation." By S. T. S. Lecky. Eighteenth edition, revised and enlarged by William Allingham. 814 pages. Price $5. (D. Van Nostrand Company, New York.)

"Wrinkles" is a book so well known to every seafaring man that the eighteenth edition, revised and enlarged and printed by the Van Nostrand Company, New York, by arrangement with the English publishers, is assured of a hearty welcome by "all hands."

This edition contains a new chapter entitled "New Meteorological Measures for Old," dealing in part with English *vs.* continental measures;

barometer and thermometer units, British and foreign; the centimeter, gramme, second system, etc.; also four new appendices as follows:

1. Substitute for Horizon.
2. Gyroscopic Compasses.
3. The Moon as Auxiliary.
4. Chronometers: Use and Abuse.

"Wrinkles" is a handy book for size, for the unique way in which the subject matter is presented, and for every seaman.

S. A. T.

"Simplified Navigation for Ships and Aircraft." By Chas. Lane Poor. 120 pages. (The Century Company, New York.)

This book, with a foreword by Rear Admiral Bradley A. Fiske, U. S. N., is one of the pioneer books in connection with aircraft navigation. It is based on the Saint-Hilaire method, and, in the words of the author, "Attempts to explain in non-technical language and without the use of complicated mathematical formulas the principles that form the basis of modern navigational methods." The book contains illustrations of a line of position computer with examples worked in connection therewith and would be interesting and valuable to any navigator.

S. A. T.

NOTICE TO MEMBERS

More members, both regular and associate, are much desired. Any increase in membership invariably means larger number of papers and essays submitted, and consequently an improvement in the PROCEEDINGS.

You are requested to send or give the attached slip to some one eligible for membership, urging him to join.

By direction of the Board of Control,

G. M. RAVENSCROFT,
Secretary-Treasurer.

Attention is invited to extracts from the constitution on the opposite page as to the requirements in making applications for life, regular and associate membership. Members and associate members are liable for the payment of the annual dues until the date of the receipt of their resignation in writing. Annual dues $2.50.

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.....*191*

To the Secretary and Treasurer,
U. S. Naval Institute,
Annapolis, Md.

Dear Sir:

Please enroll my name as a { *regular* / *associate* } *member of the U. S. Naval Institute from this date.*

Very truly yours,

.....

.....

NOTICE

The U. S. Naval Institute was established in 1873, having for its object the advancement of professional and scientific knowledge in the Navy. It is now in its forty-sixth year of existence, trusting as heretofore for its support to the officers and friends of the Navy. The members of the Board of Control cordially invite the co-operation and aid of their brother officers and others interested in the Navy, in furtherance of the aims of the Institute, by the contribution of papers and communications upon subjects of interest to the naval profession, as well as by personal support and influence.

On the subject of membership the Constitution reads as follows:

ARTICLE VII

Sec. 1. The Institute shall consist of regular, life, honorary and associate members.

Sec. 2. Officers of the Navy, Marine Corps, and all civil officers attached to the Naval Service, shall be entitled to become regular or life members, without ballot, on payment of dues or fees to the Secretary and Treasurer. Members who resign from the Navy subsequent to joining the Institute will be regarded as belonging to the class described in this Section.

Sec. 3. The Prize Essayist of each year shall be a life member without payment of fee.

Sec. 4. Honorary members shall be selected from distinguished Naval and Military Officers, and from eminent men of learning in civil life. The Secretary of the Navy shall be, *ex officio*, an honorary member. Their number shall not exceed thirty (30). Nominations for honorary members must be favorably reported by the Board of Control. To be declared elected, they must receive the affirmative vote of three-quarters of the members represented at regular or stated meetings, either in person or by proxy.

Sec. 5. Associate members shall be elected from Officers of the Army, Revenue Cutter Service, foreign officers of the Naval and Military professions, and from persons in civil life who may be interested in the purposes of the Institute.

Sec. 6. Those entitled to become associate members may be elected life members, provided that the number not officially connected with the Navy and Marine Corps shall not at any time exceed one hundred (100).

Sec. 7. Associate members and life members, other than those entitled to regular membership, shall be elected as follows: "Nominations shall be made in writing to the Secretary and Treasurer, with the name of the member making them, and such nominations shall be submitted to the Board of Control. The Board of Control will at each regular meeting ballot on the nominations submitted for election, and nominees receiving a majority of the votes of the board membership shall be considered elected to membership in the United States Naval Institute."

Sec. 8. The annual dues for regular and associate members shall be two dollars and fifty cents, all of which shall be for a year's subscription to the UNITED STATES NAVAL INSTITUTE PROCEEDINGS, payable upon joining the Institute, and upon the first day of each succeeding January. The fee for life membership shall be forty dollars, but if any regular or associate member has paid his dues for the year in which he wishes to be transferred to life membership, or has paid his dues for any future year or years, the amount so paid shall be deducted from the fee for life membership.

ARTICLE X

Sec. 2. One copy of the PROCEEDINGS, when published, shall be furnished to each regular and associate member (in return for dues paid), to each life member (in return for life membership fee paid), to honorary members, to each corresponding society of the Institute, and to such libraries and periodicals as may be determined upon by the Board of Control.

The PROCEEDINGS are published monthly; subscription for non-members, $3.00; enlisted men, U. S. Navy, $2.50. Single copies, by purchase, 30 cents; issues preceding January, 1919, 50 cents.

All letters should be addressed U. S. Naval Institute, Annapolis, Md., and all checks, drafts, and money orders should be made payable to the same.

NOTICE TO MEMBERS

More members, both regular and associate, are much desired. Any increase in membership invariably means larger number of papers and essays submitted, and consequently an improvement in the PROCEEDINGS. You are requested to send or give the attached slip to some one eligible for membership, urging him to join.

SPECIAL NOTICE

NAVAL INSTITUTE PRIZE ESSAY, 1920

A prize of two hundred dollars, with a gold medal, and a life-membership (unless the author is already a life member) in the Institute, is offered by the Naval Institute for the best original essay on any subject pertaining to the naval profession published in the PROCEEDINGS during the current year. The prize will be in addition to the author's compensation paid upon publication of the essay.

On the opposite page are given suggested topics. Essays are not limited to these topics and no additional weight will be given an essay in awarding the prize because it is written on one of these suggested topics over one written on any subject pertaining to the naval profession.

The following rules will govern this competition:

1. All original essays published in the PROCEEDINGS during 1919, which are deemed by the Board of Control to be of sufficient merit, will be passed upon by the Board during the month of January, 1920, and the award for the prize will be made by the Board of Control, voting by ballot.

2. No essay received after November 1 will be available for publication in 1919. Essays received subsequent to November 1, if accepted, will be published as soon as practicable thereafter.

3. If, in the opinion of the Board of Control, the best essay published during 1919 is not of sufficient merit to be awarded the prize, it may receive "Honorable Mention," or such other distinction as the Board may decide.

4. In case one or more essays receive "Honorable Mention," the writers thereof will receive a minimum prize of seventy-five dollars and a life-membership (unless the author is already a life member) in the Institute, the actual amounts of the awards to be decided by the Board of Control in each case.

5. It is requested that all essays be submitted typewritten and in duplicate; essays submitted written in longhand and in single copy will, however, receive equal consideration.

6. In the event of the prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of the gold medal.

By direction of the Board of Control.

G. M. RAVENSCROFT,
Commander, U. S. N., Secretary and Treasurer.

TOPICS FOR ESSAYS

Suggested by Request of the Board of Control

"Duties and Responsibilities of Subordinates with Special Reference to the Relations between Commanders-in-Chief and Chief of Naval Operations; Commanders-in-Chief and Force Commanders; Force Commanders and Division Commanders."

"Initiative of the Subordinate—Its True Meaning."

"Military Efficiency Dependent upon National Discipline."

"Governmental Organization for War."

"Naval Gunnery, Now and of the Future."

"Naval Policies."

"The Place of the Naval Officer in International Affairs."

"Moral Preparedness."

"Tact in Relation to Discipline."

"The Principles of Naval Administration in Support of War-Time Operations."

"Responsibilities and Duties of Naval and Military Officers of the United States in Educating and Informing the Public on Professional Matters."

"A Commission in The Navy: Its Meaning and the Obligations Which It Involves."

"The Relations of an Officer to his Subordinate, Both Commissioned and Enlisted."

"The True Meaning of the Expression 'An Officer and a Gentleman.'"

"Seen in the Light of Recent Events, What Should Be the United States Navy of the Future as Regards Types and Numbers of Ships."

"Probable Future Development of Surface-craft, Air-craft and Submarines and the Relation of these Types to Each Other and to Naval Warfare in General."

"The Grand Strategy of the Great War, with Especial Reference to Coördination, and Lack of Coördination, Between Naval and Military Forces."

"The Problem of Overseas Operations in the Light of Recent Developments."

"The Influence of Sea Power upon History as Illustrated by the Great War."

LIST OF PRIZE ESSAYS

"WHAT THE NAVY HAS BEEN THINKING ABOUT"

1879

Naval Education. Prize Essay, 1879. By Lieut. Commander A. D. Brown, U. S. N.

NAVAL EDUCATION. First Honorable Mention. By Lieut. Commander C. F. Goodrich, U. S. N.

NAVAL EDUCATION. Second Honorable Mention. By Commander A. T. Mahan, U. S. N.

1880

"The Naval Policy of the United States." Prize Essay, 1880. By Lieutenant Charles Belknap, U. S. N.

1881

The Type of (I) Armored Vessel, (II) Cruiser Best Suited to the Present Needs of the United States. Prize Essay, 1881. By Lieutenant E. W. Very, U. S. N.

SECOND PRIZE ESSAY, 1881. By Lieutenant Seaton Schroeder, U. S. N.

1882

Our Merchant Marine: The Causes of Its Decline and the Means to Be Taken for Its Revival. "Nil clarius aquis." Prize Essay, 1882. By Lieutenant J. D. Kelley, U. S. N.

"MAIS IL FAUT CULTIVER NOTRE JARDIN." Honorable Mention. By Master C. G. Calkins, U. S. N.

"SPERO MELIORA." Honorable Mention. By Lieut. Commander F. E. Chadwick, U. S. N.

"CAUSA LATET: VIS EST NOTISSIMA." Honorable Mention. By Lieutenant R. Wainwright, U. S. N.

1883

How May the Sphere of Usefulness of Naval Officers Be Extended in Time of Peace with Advantage to the Country and the Naval Service? "Pour encourager les Autres." Prize Essay, 1883. By Lieutenant Carlos G. Calkins, U. S. N.

"SEMPER PARATUS." First Honorable Mention. By Commander N. H. Farquhar, U. S. N.

"CULIBET IN ARTE SUA CREDENDUM EST." Second Honorable Mention. By Captain A. P. Cooke, U. S. N.

1884

The Reconstruction and Increase of the Navy. Prize Essay, 1884. By Ensign W. I. Chambers, U. S. N.

1885

Inducements for Retaining Trained Seamen in the Navy, and Best System of Rewards for Long and Faithful Service. Prize Essay, 1885. By Commander N. H. Farquhar, U. S. N.

1886

What Changes in Organization and Drill Are Necessary to Sail and Fight Effectively Our Warships of Latest Type? "Scire quod nescias." Prize Essay, 1886. By Lieutenant Carlos G. Calkins, U. S. N.

THE RESULT OF ALL NAVAL ADMINISTRATION AND EFFORTS FINDS ITS EXPRESSION IN GOOD ORGANIZATION AND THOROUGH DRILL ON BOARD OF SUITABLE SHIPS. Honorable Mention. By Ensign W. L. Rodgers, U. S. N.

1887

The Naval Brigade: Its Organization, Equipment and Tactics. "In hoc signo vinces." Prize Essay, 1887. By Lieutenant C. T. Hutchins.

1888

Torpedoes. Prize Essay, 1888. By Lieut. Commander W. W. Reisinger, U. S. N.

1891

The Enlistment, Training and Organization of Crews for Our Ships of War. Prize Essay, 1891. By Ensign A. P. Niblack, U. S. N.

DISPOSITION AND EMPLOYMENT OF THE FLEET: SHIP AND SQUADRON DRILL. Honorable Mention, 1891. By Lieutenant R. C. Smith, U. S. N.

1892

Torpedo-boats: Their Organization and Conduct. Prize Essay, 1892. By Wm. Laird Clowes.

1894

The U. S. S. Vesuvius, with Special Reference to Her Pneumatic Battery. Prize Essay, 1894. By Lieut. Commander Seaton Schroeder, U. S. N.

NAVAL REFORM. Honorable Mention, 1894. By Passed Assistant Engineer F. M. Bennett, U. S. N.

1895

Tactical Problems in Naval Warfare. Prize Essay, 1895. By Lieut. Commander Richard Wainwright, U. S. N.

A SUMMARY OF THE SITUATION AND OUTLOOK IN EUROPE. An Introduction to the Study of Coming War. Honorable Mention, 1895. By Richmond Pearson Hobson, Assistant Naval Constructor, U. S. N.

SUGGESTIONS FOR INCREASING THE EFFICIENCY OF OUR NEW SHIPS. Honorable Mention, 1895. By Naval Constructor Wm. J. Baxter, U. S. N.

THE BATTLE OF THE YALU. Honorable Mention, 1895. By Ensign Frank Marble, U. S. N.

1896

The Tactics of Ships in the Line of Battle. Prize Essay, 1896. By Lieutenant A. P. Niblack, U. S. N.

THE ORGANIZATION, TRAINING AND DISCIPLINE OF THE NAVY PERSONNEL AS VIEWED FROM THE SHIP. Honorable Mention, 1896. By Lieutenant Wm. F. Fullam, U. S. N.

NAVAL APPRENTICES, INDUCEMENTS, ENLISTING AND TRAINING. The Seaman Branch of the Navy. Honorable Mention, 1896. By Ensign Ryland D. Tisdale, U. S. N.

THE COMPOSITION OF THE FLEET. Honorable Mention 1896. By Lieutenant John M. Ellicott, U. S. N.

1897

Torpedo-boat Policy. Prize Essay, 1897. By Lieutenant R. C. Smith, U. S. N.

A PROPOSED UNIFORM COURSE OF INSTRUCTION FOR THE NAVAL MILITIA. Honorable Mention, 1897. By H. G. Dohrman, Associate Member, U. S. N. I.

TORPEDOES IN EXERCISE AND BATTLE. Honorable Mention, 1897. By Lieutenant J. M. Ellicott, U. S. N.

1898

Esprit de Corps: A Tract for the Times. Prize Essay, 1898. By Captain Caspar Frederick Goodrich, U. S. N.

OUR NAVAL POWER. Honorable Mention, 1898. By Lieut. Commander Richard Wainwright, U. S. N.

TARGET PRACTICE AND THE TRAINING OF GUN CAPTAINS. Honorable Mention, 1898. By Ensign R. H. Jackson, U. S. N.

1900

Torpedo Craft: Types and Employment. Prize Essay, 1900. By Lieutenant R. H. Jackson, U. S. N.

THE AUTOMOBILE TORPEDO AND ITS USES. Honorable Mention, 1900. By Lieutenant L. H. Chandler, U. S. N.

1901

Naval Administration and Organization. Prize Essay, 1901. By Lieutenant John Hood, U. S. N.

1903

Gunnery in Our Navy. The Causes of Its Inferiority and Their Remedies. Prize Essay, 1903. By Professor Philip R. Alger, U. S. N.

A NAVAL TRAINING POLICY AND SYSTEM. Honorable Mention, 1903. By Lieutenant James H. Reid, U. S. N.

SYSTEMATIC TRAINING OF THE ENLISTED PERSONNEL OF THE NAVY. Honorable Mention, 1903. By Lieutenant C. L. Hussey, U. S. N.

OUR TORPEDO-BOAT FLOTILLA. The Training Needed to Insure Its Efficiency. Honorable Mention, 1903. By Lieutenant E. L. Beach, U. S. N.

1904

The Fleet and Its Personnel. Prize Essay, 1904. By Lieutenant S. P. Fullinwider, U. S. N.

A PLEA FOR A HIGHER PHYSICAL, MORAL AND INTELLECTUAL STANDARD OF THE PERSONNEL FOR THE NAVY. Honorable Mention, 1904. By Medical Inspector Howard E. Ames, U. S. N.

1905

American Naval Policy. Prize, Essay 1905. By Commander Bradley A. Fiske, U. S. N.

THE DEPARTMENT OF THE NAVY. Honorable Mention, 1905. By Rear Admiral Stephen B. Luce, U. S. N.

1906

Promotion by Selection. Prize Essay, 1906. By Commander Hawley O. Rittenhouse, U. S. N.

THE ELEMENTS OF FLEET TACTICS. First Honorable Mention, 1906. By Lieut. Commander A. P. Niblack, U. S. N.

GLEANINGS FROM THE SEA OF JAPAN. Second Honorable Mention, 1906. By Captain Seaton Schroeder, U. S. N.

THE PURCHASE SYSTEM OF THE NAVY. Third Honorable Mention, 1906 By Pay Inspector J. A. Mudd. U. S. N.

1907

Storekeeping at the Navy Yards. Prize Essay, 1907. By Pay Inspector John A. Mudd, U. S. N.

BATTLE REHEARSALS. A Few Thoughts on Our Next Step in Fleet-Gunnery. First Honorable Mention, 1907. By Lieut. Commander Yates Stirling, U. S. N.

THE NAVAL PROFESSION. Second Honorable Mention, 1907. By Commander Bradley A. Fiske, U. S. N.

1908

A Few Hints to the Study of Naval Tactics. Prize Essay, 1908. By Lieutenant W. S. Pye, U. S. N.

THE MONEY FOR THE NAVY. First Honorable Mention, 1908. By Pay Inspector John A. Mudd, U. S. N.

THE NATION'S DEFENCE—THE OFFENSIVE FLEET. How Shall We Prepare It for Battle? Second Honorable Mention, 1908. By Lieut. Commander Yates Stirling, U. S. N.

1909

Some Ideas about Organization on Board Ship. Prize Essay, 1909. By Lieutenant Ernest J. King, U. S. N.

THE NAVY AND COAST DEFENCE. Honorable Mention, 1909. By Commodore W. H. Beehler, U. S. N.

THE REORGANIZATION OF THE NAVAL ESTABLISHMENT. Honorable Mention, 1909. By Pay Inspector J. A. Mudd, U. S. N.

A PLEA FOR PHYSICAL TRAINING IN THE NAVY. Honorable Mention, 1909. By Commander A. P. Niblack, U. S. N.

1910

The Merchant Marine and the Navy. Prize Essay, 1910. By Naval Constructor T. G. Roberts, U. S. N.

THE NAVAL STRATEGY OF THE RUSSO-JAPANESE WAR. Honorable Mention, 1910. By Lieutenant Lyman A. Cotton, U. S. N.

1911

Navy Yard Economy. Prize Essay, 1911. By Paymaster Charles Conard, U. S. N.

NAVAL POWER. Honorable Mention, 1911. By Captain Bradley A. Fiske, U. S. N.

WANTED—FIRST AID. Honorable Mention, 1911. By Commander C. C. Marsh, U. S. N.

1912

Naval Might. Prize Essay, 1912. By Lieutenant Ridgely Hunt, U. S. N. (retired).

INSPECTION DUTY AT THE NAVY YARDS. Honorable Mention, 1912. By Lieut. Commander T. D. Parker, U. S. N.

1913

The Greatest Need of the Atlantic Fleet. Prize Essay, 1913. By Lieut. Commander Harry E. Yarnell, U. S. N.

NAVY DEPARTMENT ORGANIZATION. A Study of Principles. First Honorable Mention, 1913. By Commander Yates Stirling, Jr., U. S. N.

TRAINED INITIATIVE AND UNITY OF ACTION. Second Honorable Mention, 1913. By Lieut. Commander Dudley W. Knox, U. S. N.

1914

The Great Lesson from Nelson for To-day. Prize Essay, 1914. By Lieut. Commander Dudley W. Knox, U. S. N.

NAVAL POLICY AS IT RELATES TO THE SHORE ESTABLISHMENT AND THE MAINTENANCE OF THE FLEET. Honorable Mention, 1914. By Captain John Hood, U. S. N.

OLD PRINCIPLES AND MODERN APPLICATIONS. Honorable Mention, 1914. By Lieut. Commander Dudley W. Knox, U. S. N.

MILITARY PREPAREDNESS. Honorable Mention, 1914. By Naval Constructor Richard D. Gatewood, U. S. N.

1915

The Rôle of Doctrine in Naval Warfare. Prize Essay, 1915. By Lieut. Commander Dudley W. Knox, U. S. N.

AN AIR FLEET: OUR PRESSING NAVAL WANT. First Honorable Mention, 1915. By Lieut. Commander Thomas Drayton Parker, U. S. N.

TACTICS. Second Honorable Mention, 1915. By Ensign H. H. Frost, U. S. N.

DEFENCE AGAINST SURPRISE TORPEDO ATTACK. Third Honorable Mention, 1915. By Ensign R. T. Merrill, 2d, U. S. N.

1916

The Moral Factor in War. Prize Essay, 1916. By Lieutenant (J. G.) H. H. Frost, U. S. N.

NAVAL PERSONNEL. First Honorable Mention, 1916. By Lieut. Commander J. K. Taussig, U. S. N.

EDUCATION AT THE U. S. NAVAL ACADEMY. Second Honorable Mention, 1916. By Lieutenant Ridgely Hunt, U. S. N.

SOME UNDERLYING PRINCIPLES OF MORALE. Third Honorable Mention, 1916. By Commander Dudley W. Knox, U. S. N.

LARGE *vs.* A GREATER NUMBER OF SMALLER BATTLESHIPS. Lippincott Prize Essay. By Lieut. Commander Thomas Lee Johnson, U. S. N.

1917

Commerce Destroying in War. Prize Essay, 1917. By Commander Lyman A. Cotten, U. S. Navy.

THE PEOPLE'S RÔLE IN WAR. First Honorable Mention, 1917. By Lieutenant H. H. Frost, U. S. Navy.

THE NATION'S GREATEST NEED. Second Honorable Mention, 1917. By Colonel Dion Williams, U. S. Marine Corps.

1918

Letters on Naval Tactics. Prize Essay, 1918. By Lieutenant H. H. Frost, U. S. N.

THE PREPAREDNESS OF THE FUTURE. First Honorable mention, 1918. By Commander H. O. Rittenhouse, U. S. N. Retired.

NAVAL STRATEGY. Second Honorable Mention, 1918. By Rear Admiral Bradley A. Fiske, U. S. N.

1919

MILITARY CHARACTER. First Honorable Mention, 1918. By Captain Reginald R. Belknap, U. S. N.

SOME REFLECTIONS ON THE THREE FACTORS OF BATTLESHIP DESIGN. Second Honorable Mention, 1918. By Lieut. Commander Beirne S. Bullard, C. C., U. S. N.